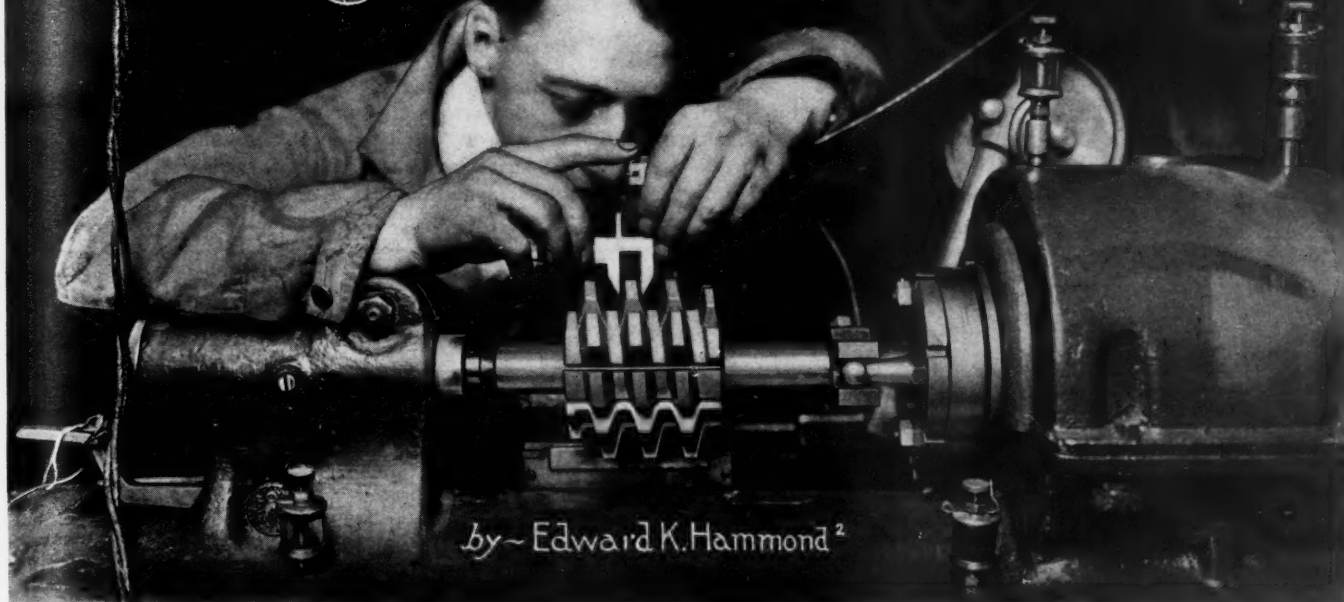


Grinding Hobs to Remove Distortion¹



by Edward K. Hammond²



WHEN gear-hobbing machines first began to be extensively used for cutting the teeth of spur, spiral, and worm-gears, there was a great deal of discussion

among mechanical men as to the relative merits of this method of gear-cutting as compared with other methods which were known to give satisfactory results. That higher rates of production could

be obtained by hobbing than by using certain other methods was generally conceded by all manufacturers who had had experience with the operation of gear-hobbing machines; but among builders of automobiles and other products in which gearing of an exceptionally high degree of accuracy was required in order to give noiseless transmission of power, the hobbing method was criticized on the ground that the quality of gears produced was not up to the required standard. Some manufacturers became so convinced of the seriousness of this lack of accuracy in hobbed gears that they changed over to other methods of gear-cutting, regardless of the fact that such methods gave lower rates of production and, hence, made the cost of gears considerably higher.

In the process of cutting gear teeth by the application of the molding-generating principle which is employed on gear-hobbing machines, it is a well-known fact that the hob teeth are of the same shape as rack teeth and that generation of the gear teeth is secured through rotating the gear blank and hob in contact with each other to produce a result that is the equivalent of rolling a gear in mesh with an ordinary straight rack. The basic principles of gear-hobbing have been fully discussed in previous numbers of MACHINERY, so that at this time it is sufficient to call the reader's attention to the fact that unless the hob used for generating gear teeth is accurate, it

In order to produce hobbed gears that will transmit power with a minimum amount of noise and that will not wear rapidly, the hobs with which the gear teeth are generated must be perfectly accurate. Regardless of the care taken in making hobs and the degree of accuracy attained before heat-treatment, a certain amount of distortion is sure to take place during the hardening process. This distortion of the hob introduces slight inaccuracies in the generated gear teeth, and trouble from this cause can only be overcome by grinding the hob after it has been heat-treated. This article describes the methods used by the Illinois Tool Works, Chicago, Ill., in grinding hobs.

is impossible for such a tool to produce accurate work. It is absolutely necessary for all dimensions of the hob teeth to be held within close limits of tolerance, and, in addition, the lead of the spiral thread of the hob must be uniformly accurate, because any deviation of the thread from a true helix of the desired lead would result in introducing inaccuracies in the gear teeth. That this is the case will at once become

apparent when consideration is given to the action of a hob and gear blank during the process of cutting teeth by the molding-generating process. Evidently, any lack of uniformity in the lead of the hob thread would result in causing successive teeth that are being cut in the gear blank to engage the hob at slightly different points, with the inevitable result that inaccuracies would be produced in the gear teeth.

Where experienced toolmakers exercise the necessary care in making hobs according to methods used by up-to-date tool-making shops, the accuracy of the finished hobs will be all that is required to produce the necessary degree of accuracy in gearing for average classes of service, without spending additional time in grinding to remove distortion produced in hardening. But extremely slight errors in the form of the hob teeth and in the lead of the thread result in producing errors of corresponding size in the gear teeth; these may seem almost too small to be worthy of serious consideration, but for the gears of automobile transmissions, for the timing gears of automobile and airplane engines, and for certain other exacting classes of service, such errors are sufficient to produce gearing which will prove to be noisy and not durable. However, particular emphasis is laid upon the fact that this article in no way condemns the usefulness of unground hobs. Such hobs have their place and are capable of producing perfectly satisfactory gears for a great many classes of service. It is only in those exceptional cases where a very slight in-

¹For additional information on hob grinding, see also "Results Obtained with Ground Hobs," published in MACHINERY for May, 1915.

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accuracy in hobbled gears would prove serious that the need arises for using a hob which has been ground to make it as nearly perfect as possible.

Effect of Distortion Produced in Hardening

When these criticisms concerning the accuracy of hobbled gears came to the attention of the builders of gear-hobbing machines and manufacturers of hobs, these men immediately started to investigate the justice of the criticism, and when this had been done, the next move was to develop means of removing the cause of the trouble. In this article we are concerned with the steps taken to correct inaccuracy in the hobs, the article being based upon the practice of the Illinois Tool Works, 154 E. Erie St., Chicago, Ill., in grinding hobs to correct the inaccuracy due to distortion produced during the process of hardening. Investigations made by this firm's engineers showed that while the errors in unground hobs were very slight, they were of sufficient magnitude to give trouble in cases where production of gears of the greatest accuracy and quiet-running properties was required. Hobs made in this firm's shops were produced on the best types of machine tools,

became obvious that the only way to overcome the difficulty was to devise some method of grinding the hobs after they had been hardened in order to remove the distortion produced while heat-treating. For over five years, engineers employed by the Illinois Tool Works have been working upon the development of this grinding process, and for the last four years hobs have been ground on a commercial basis. Patents have been granted on machines developed for grinding hobs and for performing certain other operations connected with the hob-grinding industry. The hob-grinding department of the factory, a partial view of which is shown in Fig. 1, has now been fully organized. It is the purpose of this article to illustrate and describe the hob-grinding machines and explain the method of doing this work.

Methods and Machines Used for Hob-grinding

Briefly stated, the method of grinding hobs used in this company's shops consists of grinding the space between the hob threads with a "grinding point," the shape of which conforms to the space between adjacent threads. A little thought will make it evident that this is about the only way in which

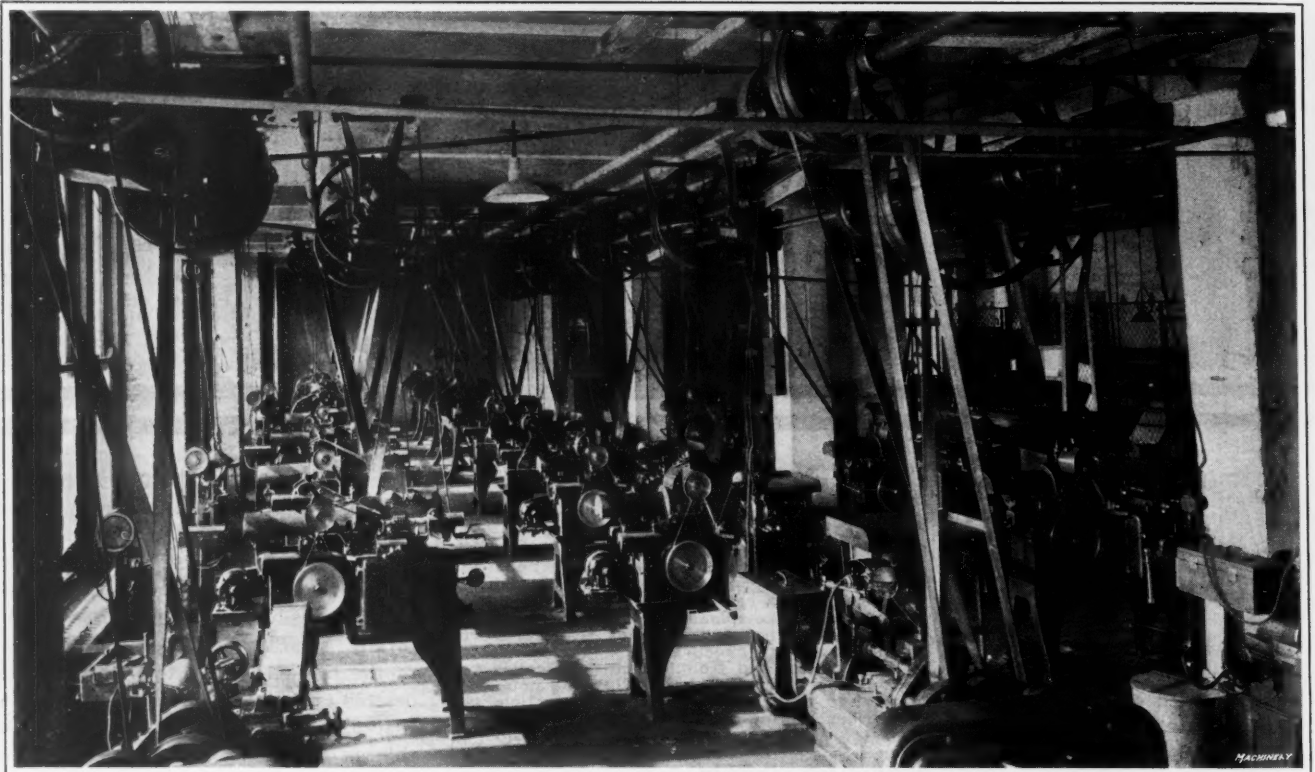


Fig. 1. View of Part of Hob-grinding Department of Illinois Tool Works

operated by specialists of experience and judgment, so that, as far as manufacturing methods were concerned, all requirements were being fulfilled. The most rigid inspection of the hobs after the machining operations had been completed showed them to be perfectly accurate, but after the hobs had been hardened, the same claim could not be made.

It is a well-known fact that there is a tendency for steel to become distorted during the process of heat-treatment, and regardless of the care which is taken, it is very difficult to overcome this trouble entirely. Where the proper precautions are taken in heat-treating, however, there will be only a very slight distortion, so that the error produced in a hob will not be of importance in the hobbled gears except where gearing of an exceptionally high degree of accuracy is required. In the case of hobs, the trouble caused by this slight amount of distortion in hardening was found to manifest itself particularly in lack of accuracy of the lead of the hob thread, and with hobs distorted in this way, there was almost sure to be lack of accuracy in the gears, due to the reasons which have already been explained. As the greatest care was already being taken in each step of the process of manufacturing hobs in the shops of the Illinois Tool Works, and as the most rigid inspection showed the hobs to be up to every reasonable requirement before heat-treatment, it at once

grinding of the hob could be accomplished, but in order to work satisfactorily, there are many interesting details of the process which have been cleverly thought out and applied; obviously, it is necessary for the spindle which drives the grinding point to be carried on a reciprocating slide, similar to the relieving attachment of a lathe, so that the grinding point will be enabled to follow the thread of the hob continuously.

Design of Hob-grinding Machine

The machine on which the hobs are ground is a special form of lathe furnished with a main carriage running on ways which extend the whole length of the lathe bed, although the carriage actually extends over each end of the lathe bed. The hob to be ground is carried by a mandrel supported on centers and driven by a dog making connection with the live center. As the hob rotates, it is also traversed past the grinding point through the action of a lead-screw which imparts the necessary feed movement to the main carriage. The grinding point is driven by a head supported on a slide which has a reciprocating movement at right angles to the line of travel of the main carriage, in order that the grinding point may follow the relief provided on the hob teeth.

Having briefly explained the features of this machine, we

are ready to take up a discussion of the way in which the machine is constructed to secure these results, and there is probably no better way than to start at the driving pulley and explain the method by which motion is transmitted to the different machine members. In Figs. 2 and 3, are shown two views of a hob-grinding machine in operation, and Fig. 4 shows plan, front, and end views of the machine. It will be seen that the main driving pulley *A* is carried on a shaft *B* journaled in the frame of the machine. This shaft carries a worm which transmits power to worm-wheel *C*; the hub of worm-wheel *C* extends out at each side for a sufficient distance so that it may be carried by bearings in brackets on the machine frame.

In this way, provision is made for rotating worm-wheel *C*, although it is maintained in a fixed position as regards longitudinal movement. Shaft *D*, that is driven by this worm-wheel, is connected to the wheel by a spline, so that it may be traversed longitudinally in addition to being rotated. At the left-hand end, shaft *D* is carried by bearings *E* in a bracket projecting down from the under side of main carriage *F*, so that the longitudinal movement of shaft *D* must correspond with any longitudinal traverse movement of carriage *F*. Through pinion *G*, power is transmitted to gear *H*, secured to the head spindle *I* that rotates the work; and secured to the rear end of spindle *I* there is a lead-screw *J* that runs in a nut *K* carried in a bracket on the main frame of the machine. As a result, rotation of spindle *I* causes lead-screw *J* to rotate in nut *K* and the main carriage *F* to be traversed along the bed of the machine.

It now remains to describe how the reciprocating transverse motion is imparted to the cross-slide which carries the grinding point. At the end of main driving shaft *B*, there is a pinion *L* from which power is transmitted through spur gears *M*, *N*, and *O* and bevel gears *P* and *Q* to an eccentric *R*; the latter fits into a slot in the under side of cross-slide *S* which supports the grinding point *T*, with the result that rotation of eccentric *R* results in imparting a reciprocating transverse motion to slide *S*. By providing the proper arrangement of gearing, rotation of the hob, traversing of the hob past the grinding point, and transverse reciprocation of the grinding point are so timed in relation to each other that the grinding point follows the hob thread and provides for grinding it to remove distortion.

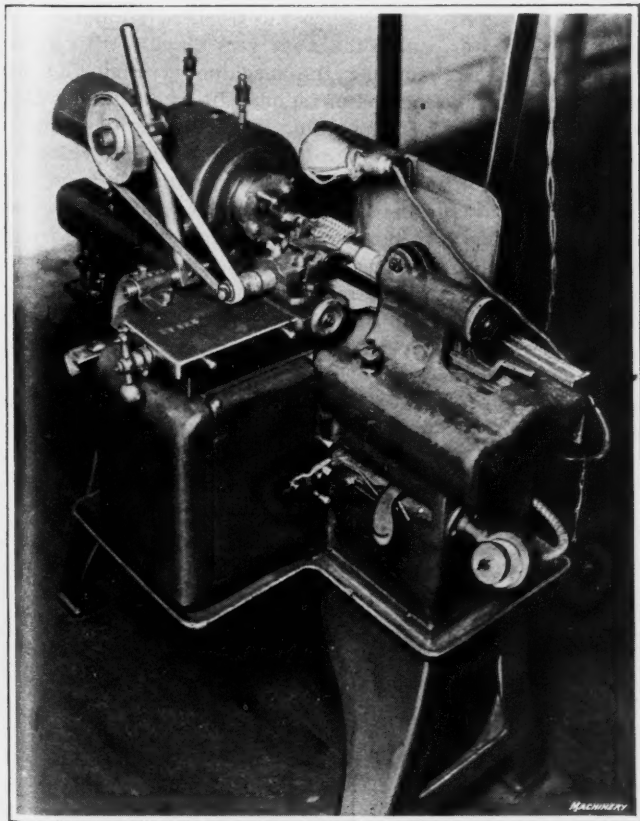


Fig. 2. Special Grinding Machine designed and built by the Illinois Tool Works for grinding Hobbs to remove Distortion produced in hardening

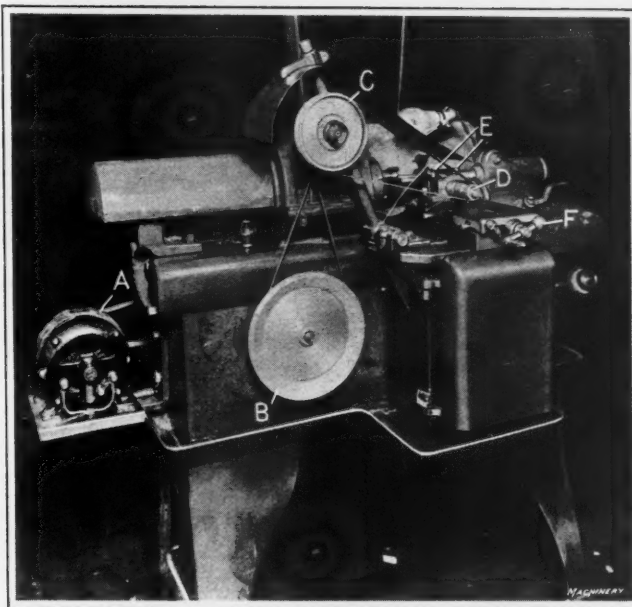


Fig. 3. View of Hob-grinding Machine showing Method of driving Grinding Spindle and setting "Grinding Point" for Different Sized Hobbs

It will be seen in the view of the machine shown in operation in Fig. 3 that there is an additional electric motor *A* bolted to a bracket at the end of the machine. The motor is belted to a pulley carried at the rear side of the machine on a transverse shaft which extends through the bed and carries pulley *B* at the front of the machine. From this pulley a belt transmits power to a shaft that carries pulley *C* from which a flat woven fabric belt drives the pulley at the rear end of spindle *D*, the grinding point being carried at the front end of this spindle. Reference to the illustration will make it apparent that the speed ratio from *B* to *C* and from *C* to *D* is increased in both cases, in order to give the required cutting speed of approximately 5000 feet per minute for the grinding point, which is of small diameter. It is necessary to true up the grinding points used on these hob-grinding machines at frequent intervals; this work can sometimes be done with the point in place on the hob-grinding machine, while, at other times, it is necessary to remove the grinding point for truing. A detailed description of this work and an explanation of the reasons for removing the work in some cases and truing it while in position in other cases, will be presented in subsequent sections of this article.

To facilitate the work of removing the grinding point for truing, a special spindle was designed which is shown in detail in Fig. 5. Here it will be seen that the spindle *A* is furnished with a draw-rod operated by thumb-nut *B* to provide for pulling arbor *C*, which carries the grinding point, back into the tapered socket of the spindle. It will also be apparent that thumb-nut *B* secures driving pulley *D* onto the tapered rear end of the spindle. Spindle *A* runs in bronze bushings *E* which are furnished with means of compensation for wear; and these bushings are secured in each end of a main sleeve *F* by a pair of lock-nuts *G*. In this way, bronze bearings *E*, sleeve *F*, and lock-nuts *G* constitute the equivalent of a single bushing in which spindle *A* is free to rotate, making it possible for the spindle and its bearing to be removed from the machine as a unit.

Referring to Fig. 3, it will be seen that on the cross-slide that carries the grinding spindle, there are two wing-nuts *E* that provide for tightening a cap over the bracket in which the grinding spindle is mounted. In setting up the grinding point in the carriage, sleeve *F*, Fig. 5, is placed in the socket in this bracket, and the cap is placed on top of sleeve *F* and then tightened by means of wing-nuts to secure the spindle firmly in place in the carriage. After this has been done, ball-crank *F*, Fig. 3, provides means of adjusting the position of the grinding point relative to the hob which is to be ground. When it is necessary to true the grinding point, the spindle is removed by loosening wing-nuts *E*, and then the entire spindle unit can be taken out and set up in the grinding point truing machine.

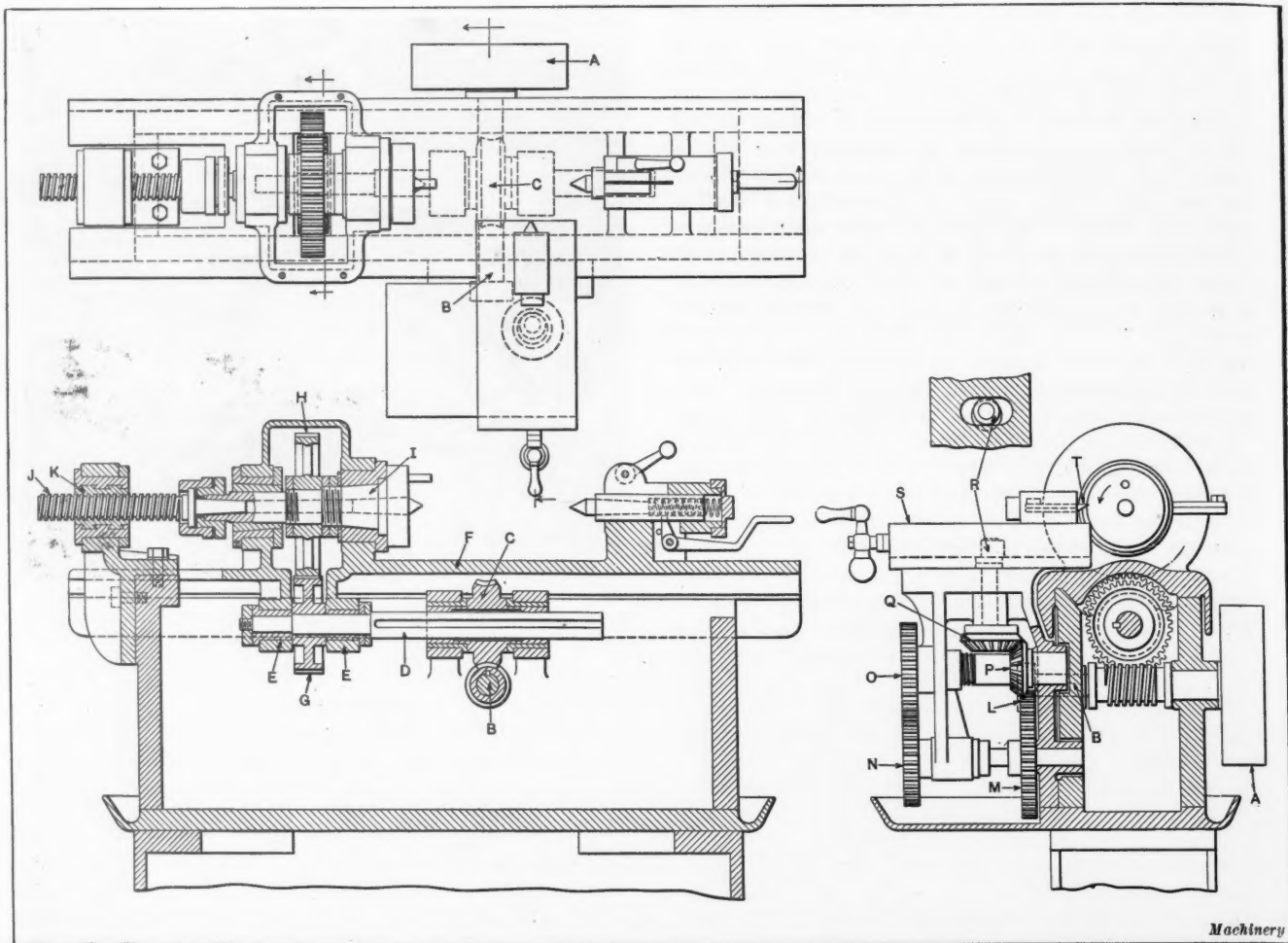


Fig. 4. Plan, Front, and End Views of Hob-grinding Machine, showing Arrangement of Driving and Feed Mechanism

Truing Grinding Points

In grinding hobs, two types of grinding points are used, one of these being shaped like the frustum of a cone, while the other is of similar shape, except that it is formed on the side instead of being straight. Devising methods for truing up the grinding points to bring them accurately to these forms was one of the most difficult problems that had to be solved. Finally two systems were devised, both of which give satisfactory results for truing the two types of grinding points. For points the shape of which is the frustum of a cone, the truing device is mounted directly on the hob-grinding machine, so that the grinding point may be trued up without removing it from the machine; but in the case of grinding points, the sides of which are formed, it is necessary to remove the point to a special truing machine.

Figs. 6 and 7 show a machine using a grinding point formed to the true frustum of a cone, and the means provided for truing the grinding point. Referring to the first of these illustrations, it will be seen that attached to the hob-grinding machine, there is a plate A, the top surface of which is accurately finished and inclined to the horizontal at an angle corresponding to the angle that the sides of grinding point B make with the horizontal axis. Sliding over the top of plate A, there is a plate C on which is carried a rod D at the lower end of which there is a diamond for truing up the grinding point. An adjusting screw E furnished with two lock-nuts provides for regulating the vertical position of rod D and locking this rod in the desired position, so that the diamond is located properly for truing up

the grinding point. In this connection, attention is called to the fact that there is a groove extending into plate A from the front edge (this groove is covered by plate C) to provide clearance for rod D, so that, when plate C is slid back and forth over plate A, rod D can have the necessary movement to enable the diamond to true up the grinding point. The advantage of this method is that when the grinding point requires truing, the operator can do the work very quickly without the necessity of either stopping the machine or removing the grinding point. The method of truing will be best understood by referring to Fig. 7 after reading the preceding description.

In Fig. 8 is shown the type of machine used for truing up grinding points for hobs where the teeth are of such form that it is necessary to true the grinding point to some shape other than the true frustum of a cone; and Fig. 12 shows part of the mechanism of this machine. In connection with the description of the hob-grinding machine, an explanation was presented of the way in which the spindle for carrying the grinding point is constructed. This spindle design was worked out with the view of facilitating truing of the grinding point. These grinding machine spindles are constructed with a bushing, shown at A in Fig. 12, which enables the spindle to be

set up interchangeably in either the hob-grinding machine or the grinding point truing machine, by simply tightening hand-screw B that secures a bearing cap down onto this bushing which supports the grinding spindle. It will be apparent from the illustrations that this machine is designed on the pantograph principle, a master form or templet C being made of the shape required for the grinding point and a reduction made from this form to

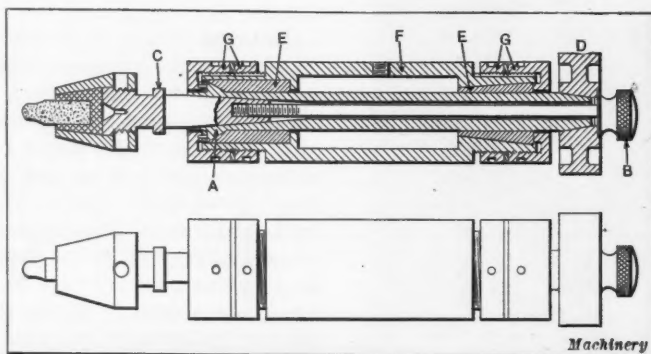


Fig. 5. Design of Grinding Spindle which is Interchangeable between Grinding Machine and Truing Machine

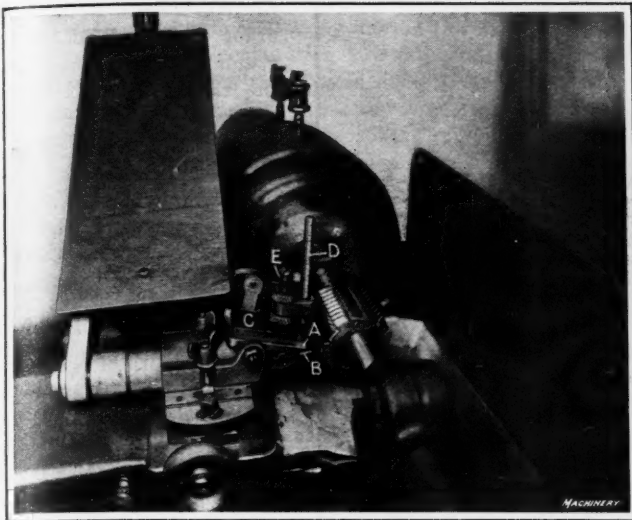


Fig. 6. Provision made for truing Grinding Point without removing it from Hob-grinding Machine

the grinding point *D* by means of a 3 to 1 pantograph link mechanism. It will, of course, be evident that at one extremity of the pantograph there is a guide pin that runs in contact with master form *C*, while at the other end there is a diamond which trues grinding point *D* up to a shape exactly

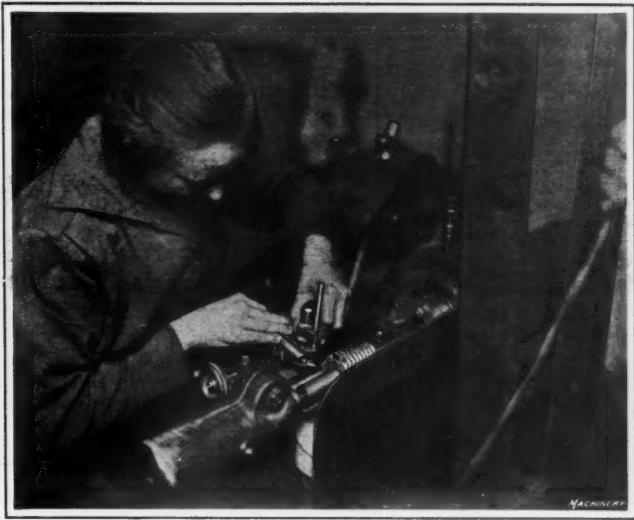


Fig. 7. Grinding Point Truing Device of Type shown in Fig. 6, in Operation

carrying the diamond point and the outline to which it is required to true up the grinding point. It is particularly important to maintain the angle between the diamond bar and the grinding point constant during the entire truing operation, because, if the manner in which the diamond is presented to

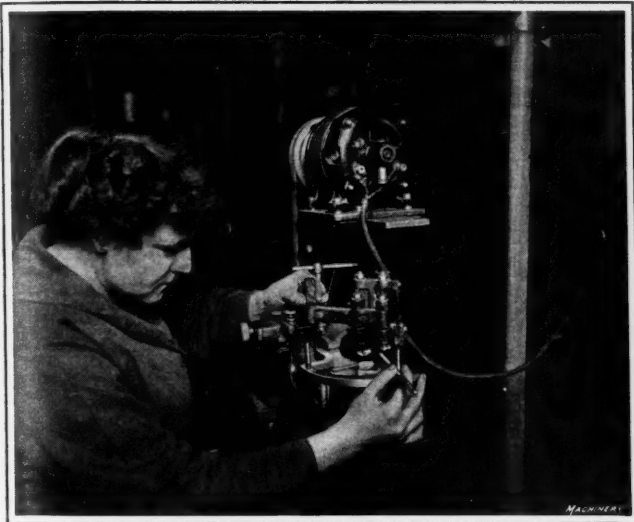


Fig. 8. Special Truing Machine for Grinding Points formed to Some Other Shape than Frustum of Cone

the same as form *C*, but of one-third the size. Through the use of a 3 to 1 pantograph link mechanism, it is possible to make the master form *C* to a larger scale, which facilitates the work of toolmaking.

As the guide pin runs over form *C* there is, of course, a definite relation between the angle of the pantograph bar



Fig. 9. Method of gaging Hob during Grinding Operation to test Accuracy of Angle of Side of Thread

the grinding point varies, a difference in the shape of the diamond, which is always irregular, is almost certain to result in inaccuracy of the form of the grinding point. Provision for maintaining the required relation is furnished by means of the guide-bar *E* which is attached to the yoke that carries the diamond. While truing the side of the grinding point, bar *E*

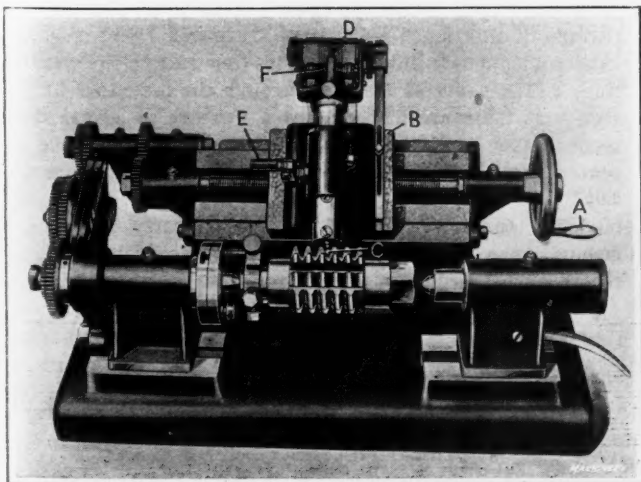


Fig. 10. Front View of Gaging Machine for measuring and recording Magnitude of Error in Lead of Hob Thread after grinding

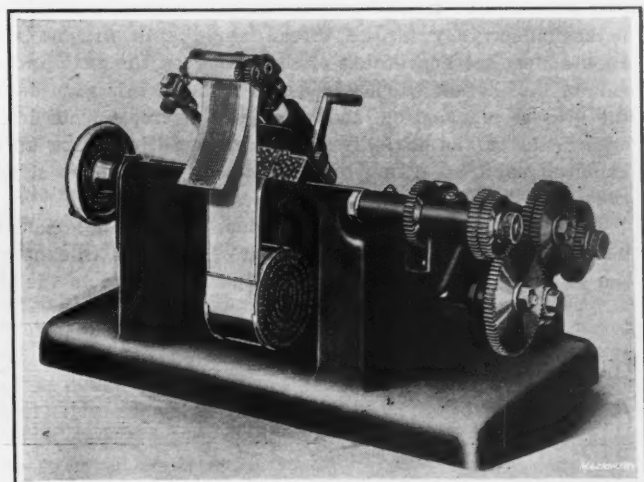


Fig. 11. Opposite Side of Gaging Machine shown in Fig. 10, illustrating Arrangement of Reel for feeding Record Paper past Pen

is made to slide in contact with pin *F* as the pantograph links go through their movement in reciprocating the diamond and guide pin back and forth over the diamond point and master form, respectively. Then, when the side of the point has been trued up and it is desired to true the end, which is accomplished by moving the guide pin over the square end of form *C*, rod *E* is brought down so that it slides in contact with pin *G*, thus maintaining a uniform relation between the diamond and grinding point while the end of the point is being trued up. After this operation has been completed, hand-screw *B* is loosened so that the entire grinding spindle may be taken out of the truing machine and transferred to the hob-grinding machine where the spindle is secured in place in a similar bearing holder.

Determining when Grinding Operation is Completed

In grinding a hob, the machine is so designed that the grinding point is traversed around the hob until it has traveled from one end to the other, after which it is backed away and the carriage traversed back to the starting point, where the grinding point is once more brought into contact with the hob ready for the next traverse. This operation is analogous to the familiar operation of thread chasing, but in grinding a hob to eliminate distortion produced in hardening, the depth of the cut is extremely light and the greatest care must be taken not to grind away a sufficient amount of metal to make the thickness of the hob thread less than the required dimension. During the early stage of the grinding operation, the machine operator is guided by the removal of the steel surface which was discolored while hardening, but when this means of guidance is gone, he must depend upon the use of gages to determine what results are being produced.

In the first place, it is necessary to watch the angle of the side of the thread carefully to see that this is maintained standard, because wearing of the grinding point may easily result in producing an inaccurate thread angle, which would make the hob worthless. For this purpose, the operators of the hob-grinding machines make use of gages of the form shown in Fig. 9. These are simply flat steel gages very accurately formed, which are used by placing a piece of plate glass in successive hob gashes, so that the glass rests against the cutting edges of the teeth, and then bringing the gage up against this glass in the manner shown in the illustration. If there is any inaccuracy in the thread angle, this will be made apparent by the appearance of light between the gage and the side of the thread. Repeated use is made of this gage during the process of grinding, and when any discrepancy is discovered in the thread angle, it must be removed by truing up the grinding point according to the methods which have already been described.

The two ultimate tests to show when the grinding operation has been completed are measurement of the tooth thickness at the pitch line with a gear tooth caliper, as shown in the title

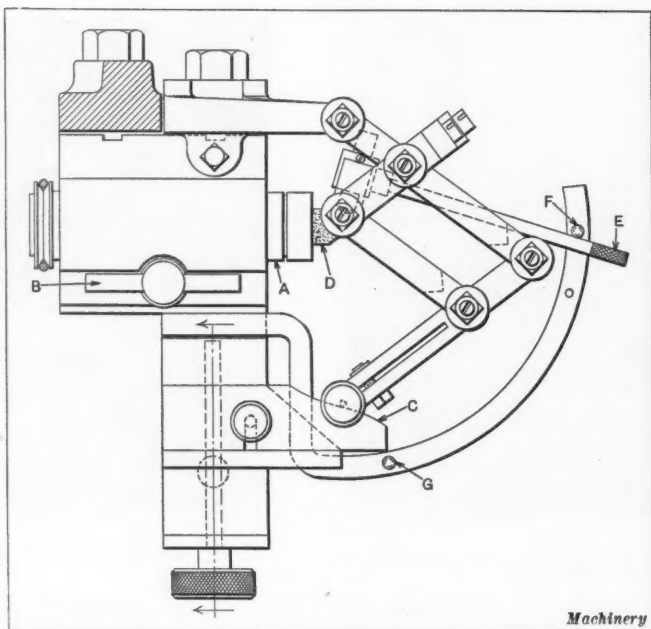


Fig. 12. Arrangement of Master Form, Pantograph, and Diamond on Grinding Point Truing Machine of Type shown in Fig. 8

illustration of this article, and proof that the hob has been ground, so that the lead of the thread is both accurate and perfectly uniform. Uniformity of the lead is determined by carefully listening to the "hum" of the grinding point as this point is traversed from one end of the hob to the other. Experienced operators of hob-grinding machines become proficient in judging the uniformity of lead by this method, and if, in their judgment, the sound made by the grinding point in traversing over the full length of the hob is quite uniform, it will generally be found that the desired degree of uniformity has been obtained when the hob is sent to the inspection department and subjected to a rigid test under a precision gaging machine.

Gaging Machine with Recording Attachment for Testing and Tabulating Magnitude of Error in Lead of Hob Thread

In Figs. 10 and 11, are shown front and rear views of a special machine built for use in testing and automatically recording the magnitude of errors in the lead of the hob threads for each successive tooth of the hob. It will be seen that this machine is provided with centers supporting an arbor that carries the hob to be tested, and that a dog connects the arbor to the live center. By turning handwheel *A*, the lead-screw traverses carriage *B* along the ways of the machine so that gaging point *C* and the recording mechanism *D* are traversed from one end of the hob to the other. At the left-hand end of the lead-screw which traverses carriage *B*, it will be seen that connection is made through gearing with the live center, which provides for rotating the hob as gaging point *C* is traversed along the hob. In operating this machine, handwheel *A* is turned until gaging point *C* comes opposite the space between two adjacent teeth on the hob, the gaging point being normally located at a point above the tops of the hob teeth.

Rotation of handwheel *A* is then stopped and lever *E* is pulled forward, which results in forcing the gaging point *C* down into the space between the hob teeth. The gaging point is pivoted in such a way that it actuates a set of multiplying levers which manipulate arm *D* that carries the recording pen. The arrangement of this recording mechanism will perhaps be better understood after referring to the rear view of the machine, where it will be seen that a reel is provided that feeds a strip of paper through rollers which move the paper through the machine continuously as the gaging operation progresses from tooth to tooth of the hob. An interesting feature of this machine is that a grooved roller *F*, which is kept continuously inked, provides for ruling the graduation lines on the paper as it is fed through the machine. It will be seen that there are fifteen lines which are so spaced that the record paper is divided into seven spaces on each side of the center line, indicating errors in the hob thread from 0 to 0.007 inch, respectively. Fig. 13 shows one of the records made on the machine, and indicates clearly how close the ground hobs come to being perfectly accurate. While the record paper is ruled to provide for an error of 0.007 inch, such

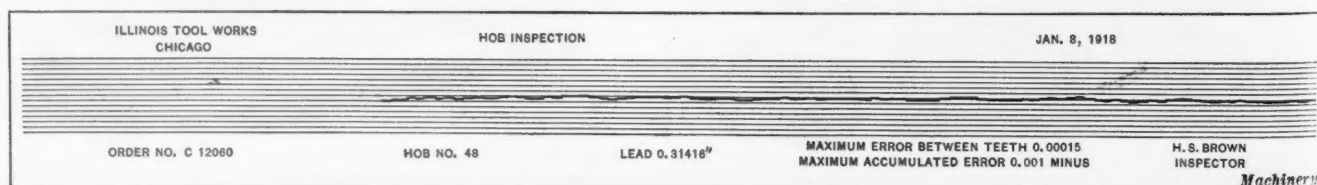


Fig. 13. Record of Magnitude of Error in Lead of Hob Thread tested on Gaging Machine shown in Figs. 10 and 11

an error is never found in the ground hob. An important feature of this machine is that by having the gaging point *C*, Fig. 10, enter the space between two adjacent teeth, that is to say, come in contact with opposite sides of the thread, which are separated from each other by one revolution of the thread around the body of the hob, the machine provides for gaging both sides of the thread simultaneously to make sure that the lead of both sides is uniform within the required limits.

* * *

SNAGGING MALLEABLE IRON CASTINGS¹

Malleable iron castings are important factors in the production of agricultural implements, automobile and railway equipment, and various other classes of work subjected to corrosion and shock. The grinding of these castings has become a subject of much importance to the foundry superintendent and the grinding wheel manufacturer. In selecting the grinding wheel best adapted for any particular class of work, the physical properties, size, and shape of castings must be taken into consideration.

A malleable casting is made of a special grade of cast iron, chilled in a sand mold and then annealed. Before annealing, the castings are very hard and brittle, showing a white fracture when broken, the carbon contained then being in the combined form. The castings are annealed by being packed with rusted rolling mill scale in cast-iron annealing pots and heated to a redness for a period of about sixty hours. The oxide of iron yields a portion of its oxygen to the metal which is decarbonized, giving off carbonic oxide. In this process most of the combined carbon is removed, leaving the remainder in the form of graphitic carbon surrounding the molecules of iron. This carbon gives the fracture a black appearance, termed "black-heart," which is the appearance of 95 per cent of our American product. The European methods produce a white-heart casting, due to a longer heat-treatment in which nearly all of the carbon is removed by oxidation.

Physical Characteristics

The American malleable iron castings have an elongation of approximately 11 per cent in two inches, and a tensile strength of from 40,000 to 50,000 pounds per square inch. As a result of extensive tests carried out in 1914, 72 per cent of the malleable iron castings tested showed a tensile strength of over 44,000 pounds per square inch; in 1915, 86 per cent; and in 1916, nearly 90 per cent of the castings tested showed a tensile strength of over 44,000 pounds per square inch. From these tests it will be seen that the physical properties of malleable iron castings are changing and that they vary at different foundries. The surface, at least, of malleable cast iron is essentially a low-carbon steel and possesses similar physical properties.

Wheels and Abrasives for Grinding

Alundum or some aluminous abrasive should be used on annealed malleable iron castings. Small castings are often ground on bench stands mounting 10- or 12-inch diameter wheels, 1 to 2 inches thick, with 1¼-inch holes. For grinding heavy castings, 18- or 24-inch wheels are sometimes mounted on swing-frame grinding machines, but the following sizes, mounted on floor stands, are most commonly used:

Diameter, Inches	Thickness, Inches	Diameter of Arbor Hole, Inches
14	1½-2	1½
16	1½-2-2½	1½
18	2 2½-3	1¾
20	2 2½-3	2
24	2 2½-3	2

Assuming the physical properties to be uniform, the size of grain to be used would depend chiefly on the size of the fins and gates, the rate of cutting, and the finish desired. While the grade depends on the area of contact between the wheel and the work, the surface speed of the wheel depends on the size of the castings and the method of applying the work to the wheel. The following three types of wheels are most generally used on annealed castings:

24-Q alundum vitrified, for castings up to five pounds.
20-R alundum vitrified; for miscellaneous castings from five pounds to twenty-five pounds.

20-S alundum vitrified, for large castings and castings having sharp fins and narrow edges.

For grinding unannealed castings, a carbide of silicon abrasive is best adapted, such as crystolon. The grains employed range from 16 to 24 and the grades from R to U crystolon vitrified. For the majority of work, 20-S crystolon vitrified will be found efficient. The surface speed of wheels should range from 5000 to 6000 feet per minute. Any speed below 5000 feet per minute results in a rapid wear on the wheel and a lower rate of production.

In order to know exactly what each grinding wheel is doing, the following records should be kept: the length of time that the wheel is in continuous service and the tonnage of castings ground, and the abrasive consumed or lost by the wheel. From these records, and knowing the cost of abrasive per cubic inch, monthly reports should be made showing: (1) pounds ground per hour, indicating rate of cutting; (2) abrasive cost per ton of castings ground; (3) abrasive cost per cubic inch for ton of castings ground. The use of wheels showing the lowest abrasive costs may not show a low labor cost or maximum daily production. With these records at hand, it should be an easy matter to bring the rate of production and abrasive costs to values showing the highest efficiency consistent with the labor costs.

Testing a New Wheel

When a new wheel is to be tested, the following method will be found simple and easily carried out. Mount a regular stock wheel on one end of the spindle of a double floor stand, and on the other end mount the new wheel to be tested. Have the two grinders take their castings from the same pile, and have them change daily from one wheel to the other. By keeping accurate records of the wheel life and production, the comparative efficiency of the new wheel is found as accurately as can be determined.

List of Wheels Adapted for Grinding Annealed Castings

1. Use alundum wheels.
2. Most commonly used wheels: 24-Q; 20-R; 20-S. Railroad journal boxes, 10-W. Automobile castings, 20-S. Miscellaneous barn hardware, 16-Q. Heavy railroad castings, 16-S. Journal boxes, 80 to 140 pounds, 10-T. Miscellaneous castings large and small, 16-R.

List of Wheels Adapted for Grinding White Iron (Unannealed) Castings

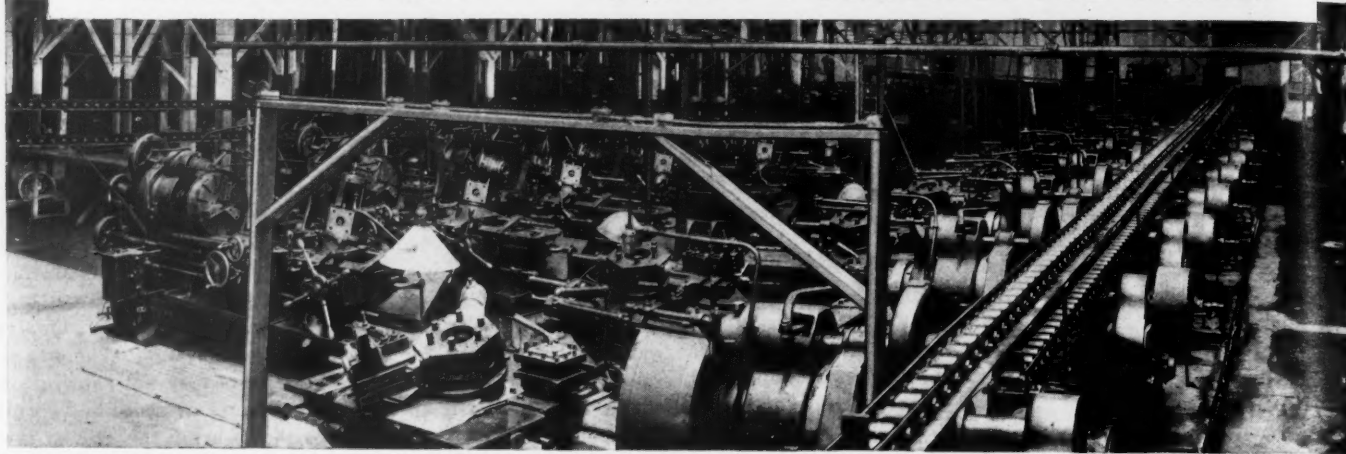
1. Use crystolon wheels.
2. Most commonly used wheels: 16-R; 20-S; 16-S. Agricultural links, 16-S and T. Pipe fittings, 20-S. Automobile parts, 20-S. Parts of metal beds, 24-V. General smoothing, 16-R. Small automobile castings, 16-R.

* * *

Some of the experiences of manufacturers of machinery with users of their product are almost incredible. They indicate in many cases profound ignorance of mechanical principles and tool action. A maker of drilling machines received a complaint that a machine purchased several months before was not giving satisfaction. The superintendent took the train and went to the plant. On presenting his card and explaining his mission he was taken into the shop to the job. The foreman explained that the feed gears broke repeatedly and that the production of drilled holes was very slow. The superintendent started the machine and began to drill a hole. He quickly discovered that the drill entered the piece very slowly, and disengaged the feed. The center of the hole was brightly burnished. Removing the drill, he saw that it had been ground with no clearance, and the bearing was some distance back of the cutting edges. The situation was critical; he courteously asked permission to touch up the drill on a nearby emery wheel, and in a few moments had the drill cutting metal at a lively rate. Neither the foreman nor the superintendent of the plant seemed to realize the importance of correct drill grinding, although the concern was a large manufacturer.

¹Abstract of an article by W. T. Montague in "Grits and Grinds"

Manufacture of the U.S. 75-Millimeter Shell



WHILE millions of shells have been made in the United States during the past three years, and a great many articles have appeared relating to the methods used by various manufacturers, nothing has been published since the entrance of the United States into the war on the making of the shell that will probably be most generally used by the United States Army. One of the most highly standardized plants for the manufacture of these shells is that of the American Shell Co., Paterson, N. J., which, under the managership of Carl G. de Laval and under the direct supervision of A. H. Williams, general superintendent of the company, who is responsible for the mechanical developments, has been completely equipped for the making of the United States 75-millimeter high-explosive shells. The reason why the United States is using the 75-millimeter shell is because the guns used for this shell are an adaptation of the French 75-millimeter type. This plant will be likely to be used as a model for some fifty other plants which are preparing to make the same shell, and, hence, a description of this plant, its methods, and the problems that have been solved in its equipment, will prove of great value in the manufacture of these shells all over the United States. While in the past this factory has been making Russian 3-inch shells, it has been entirely rearranged for making the United States ammunition; different methods have been adopted for many operations, and improved facilities have been installed for handling and routing work.

The plant of the American Shell Co. has been laid out with a view to finishing 10,000 shells per day. It has been termed an "automatic" plant on account

First of a Series of Articles Describing Approved Methods Employed by the American Shell Co. in the Making of U. S. Ammunition — By Erik Oberg¹

of one of the prominent features involved in its lay-out—that of having all the machines for the different operations so arranged that the shells pass continuously through the shop, an efficient conveyor system having been developed for this purpose, so that there is no trucking of material of any kind throughout the whole plant. The rough forgings, which are supplied by an outside concern, enter on a conveyor at one end of the shop, and the finished shells, properly inspected, varnished, and ready for loading, pass out of the shop on another conveyor at the other end, to be packed and shipped. The conveyor system is developed to such an extent that the shells are fed and timed automatically through the heat-treating furnaces, and pass on conveyors through the quenching oil tanks. The shells also pass by the same conveying system to and from every inspection and testing table. A general view of one department in the plant, typical of the appearance throughout the shop, is shown in Fig. 1.

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General Lay-out of Plant

Fig. 2 shows the general lay-out of the plant. As the forgings are not of exactly the right length when received from the forge plant, they are cut to size in a shop provided with

hacksaw machines, which is located outside of the plant proper. From the saw shop, the shells enter the main plant on an elevating conveyor at A and are discharged onto a gravity conveyor, arriving at three centering machines located at B. From the centering machines, they pass to a battery of rough-turning machines at C, ten of which are located on each side of the conveyor. From the rough-turning machines, the shells pass to the

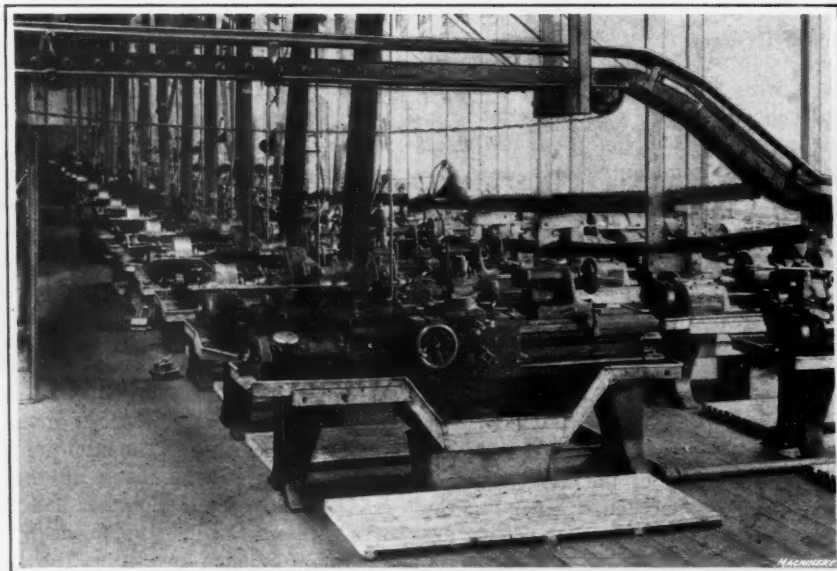


Fig. 1. General View of a Department in the American Shell Co.'s Plant

¹Editor of MACHINERY

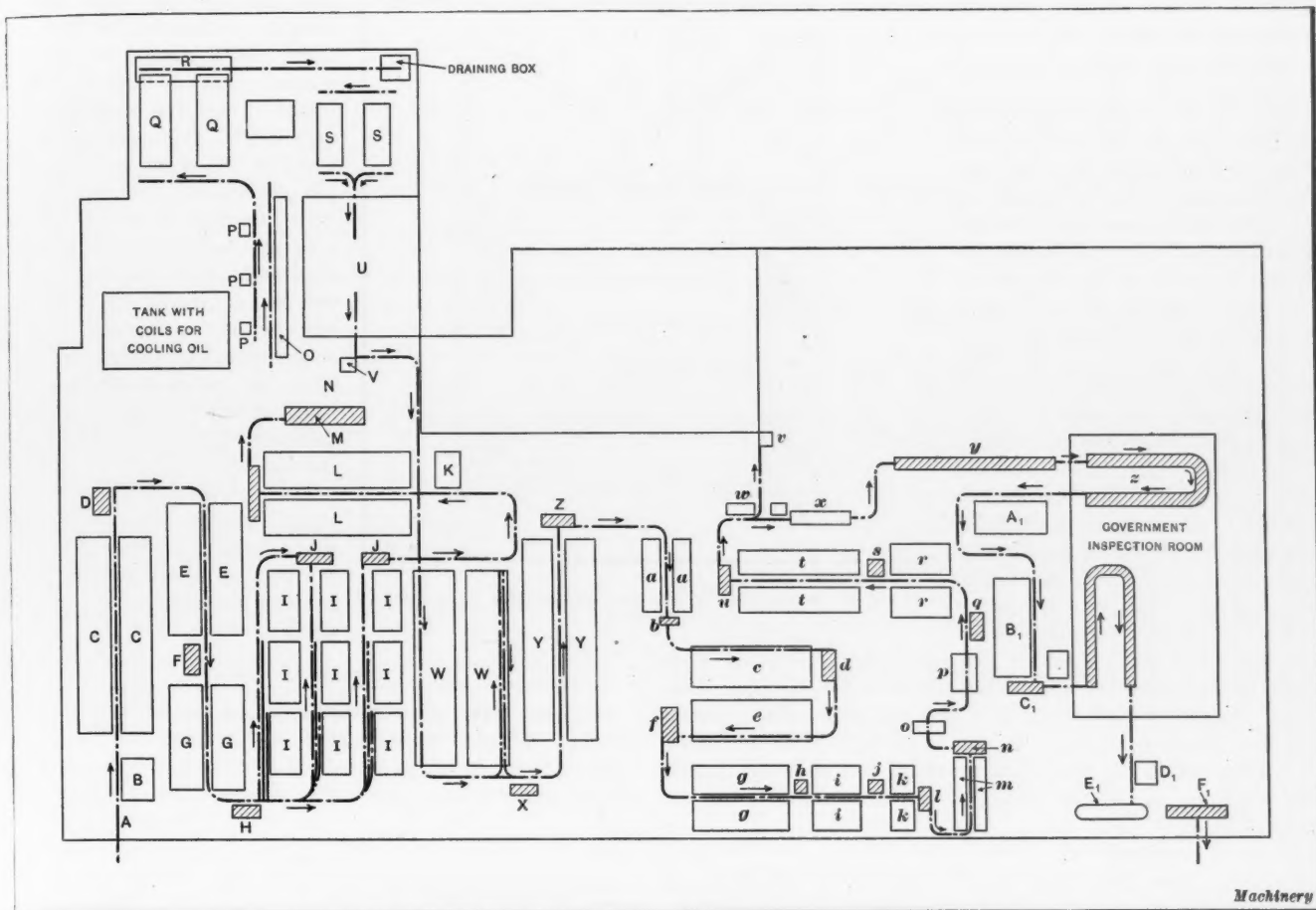


Fig. 2. Plan of Plant showing how Shells pass continuously through Works

inspection table at D, and from here to two batteries of eight machines on each side of the conveyor at E, for rough-facing the base. They are again inspected at F, and then pass to two batteries of six machines each at G, for rough-facing the open end. After again having been inspected at H, they pass onto three sets of conveyors to the machines at I, where the inside is reamed and the inside of the bottom finished. For these operations, sets of three machines are provided, one for rough-reaming, one for finish-reaming, and one for finishing the bottom, there being nine sets of these machines in all—three sets along each conveyor.

After having passed the inspection tables at J, the work passes to the two centering machines at K for a second centering, and to the two batteries of eight machines each at L for the second rough-turning. Another inspection table is located at the end of this battery of machines, from which the shells pass to the first government inspection at M. In the space at N, the shells are then stored in piles, according to the heat number of the forgings which is stamped on them; these heat

numbers remain on the shells during the entire passage through the shop. It is necessary to keep the shells in separate piles, according to the lot in which they belong at the time of forging, in order that they may be given the proper heat-treatment in the shop. From the storage place, they are put onto a conveyor passing in front of five heat furnaces at O, from which they are transferred across the passageway to the three nosing presses P, a conveyor in front of which carries them to the furnaces Q in which they are heated for hardening. The shells are carried on automatic timing conveyors through the hardening furnaces and are discharged on an automatic conveyor in the oil tank at R, by which they are moved up an incline for draining and deposited in a draining box; from here they are carried by a conveyor in front of the tempering furnaces, through which they pass automatically, and are discharged onto automatic conveyors at the back of the furnaces at S. These conveyors carry them into the cooling shed U, where they are stored until cold. They then pass by a conveyor back into the shop proper to a Brinell testing

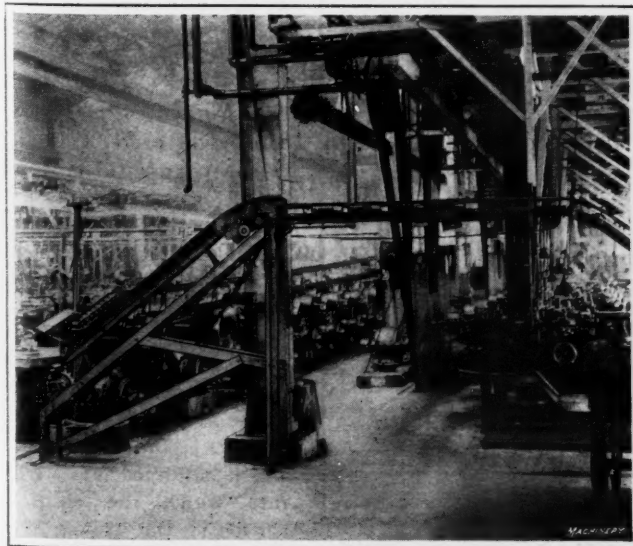


Fig. 3. Elevating Power Conveyor carrying Shells over Passageways

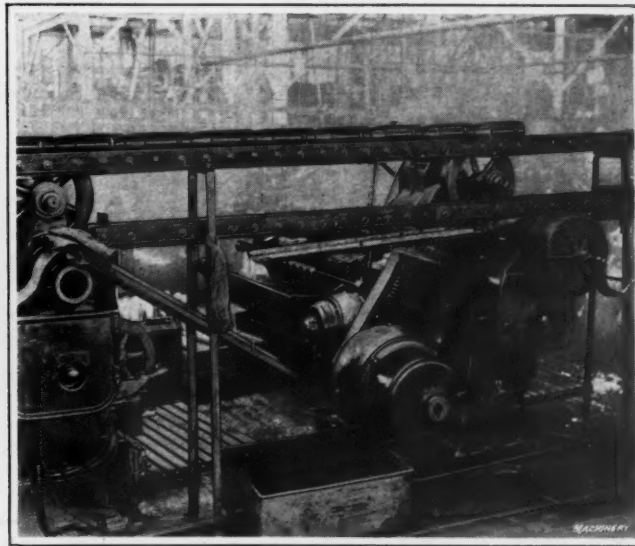


Fig. 4. Gravity Conveyors which carry Shells to and from Machines

press V, where 10 per cent are tested to determine if the heat-treatment has given them the proper hardness. A conveyor then carries them to the base-finishing machines W, which are grouped into two batteries of four machines each. After an inspection at X, the shells pass to the boring, recessing and open-end facing machines Y, ten of which are located on each side of the conveyor. After having been again inspected at Z, they pass to the grooving and knurling machines at a; there are ten grooving and two special automatic knurling machines.

After inspection at b, the shells pass to the four rough-nosing machines c, the inspection table d, the eight finish-nosing machines e, the inspection table f, the finish-turning machines g, of which there are seven on each side of the conveyor, and the inspection table h. At i, there are four finish-base-turning machines on each side of the conveyor. Another inspection takes place at j, and the shells then pass to the four beveling machines k. An inspector's table is located at l, from which the shells are conveyed to the twelve grinding machines at m for grinding the bourrelet. After an inspection at n, two presses o are passed, where the boss for the center is removed. The journey is continued past the six base-finishing machines p, the inspection table q, the eight machines for cutting and under-cutting the base cover groove r, inspection table s, and the twelve thread milling machines t, six on each side of the conveyor. After inspection at u, 10 per cent of the shells are tested in the hydraulic press v and then returned to the finish-tapping machines w, after which all the shells are notched for the detonator and passed through the washing machine x. The final shop inspection then takes place at y and the government inspection at z; then the shells return to the shop to have the copper bands pressed in place and turned; five band presses are located at A, and five band-turning machines at B. An inspection table is located at C. The base cover is now put in place, after which a second government inspection is made. The shells now pass from the government inspection room to the numbering machine D, and lacquering machine E, after which they are put in cartons at F, and are conveyed directly into the railway car by a conveyor.

The machine equipment enumerated is intended, as mentioned, to take care of a production of 10,000 shells per day, the shop running three shifts of eight hours each. The average production

per machine per hour may be roughly calculated in each case from these data. In most instances, each machine requires one operator, as the operations are very brief. There are some exceptions to this rule, however. The ten hacksaws for cutting the rough forgings to length are operated by one man; two of the machines for both the first and second rough-turning operations are run by one man; and two machines are also operated by one man for rough-facing the base, rough-facing the open end, boring the hole for the fuse, and milling the thread.

On all the machining operations, except where otherwise noted, high-speed steel is used for the cutting tools; stellite is used in one instance—for the first rough-turning.

Conveying System

Different types of conveyors are used for carrying the shells through the plant while in process of manufacture, some being power-driven elevating conveyors, some belt conveyors, and others gravity conveyors. Fig. 3 illustrates a power-driven elevating conveyor to the left, and a belt conveyor in the center. The shells are generally carried up from the inspection tables to a suitable height by an elevating conveyor and are then passed over passageways by belt conveyors, after which they pass by gravity on roller conveyors to the various machines. By this arrangement, the shells are carried clear of passageways and at the same time to a height which makes it possible to give the gravity conveyors the required inclination, so that the shells will roll along on the rollers to the machines. A view illustrating the gravity conveyors is shown in Fig. 4. Two conveyors are generally arranged one above the other, the shells to be operated upon passing along upon the lower conveyor and, after the operation is completed, being placed by the operator upon the upper conveyor, on which they pass to the next inspection table. The belts for the belt conveyors used for carrying the shells over passageways are provided with small metal guides or strips upon which the shells rest. Suitable guides are also provided on the sides to prevent the shells from falling from the conveyor.

Belt conveyors are used for carrying the chips from the machines. The belt has a frame around it, as indicated in Fig. 5, the upper part of which is formed into a trough into which the chips are shoveled; the trough has a 3-inch opening in the center,

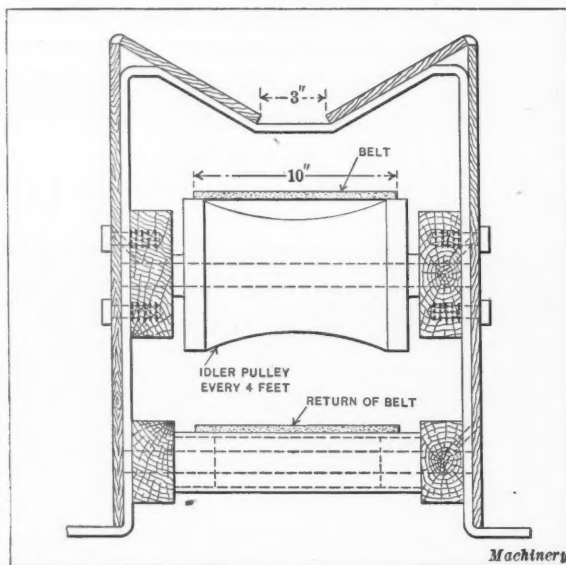


Fig. 5. Arrangement of Belt Conveyor carrying Chips from Machines

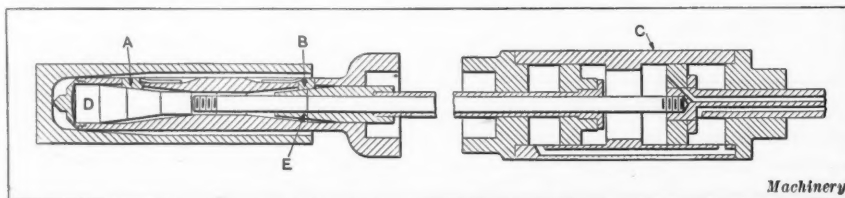


Fig. 6. Diagrammatic View of Pneumatic Centering Arbor used in Centering Machines

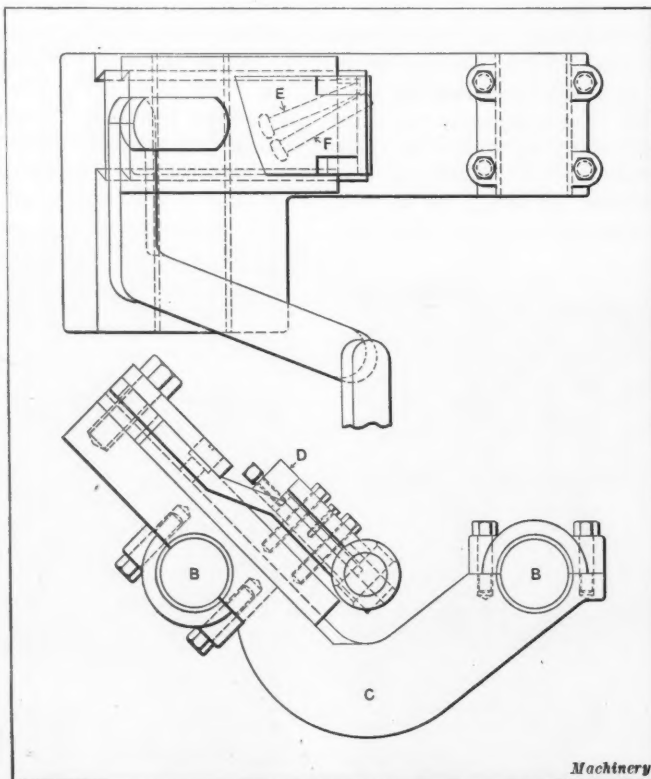


Fig. 7. Diagrammatic View of Facing Tool used in Hydraulically Operated Machines for facing Base of Shells

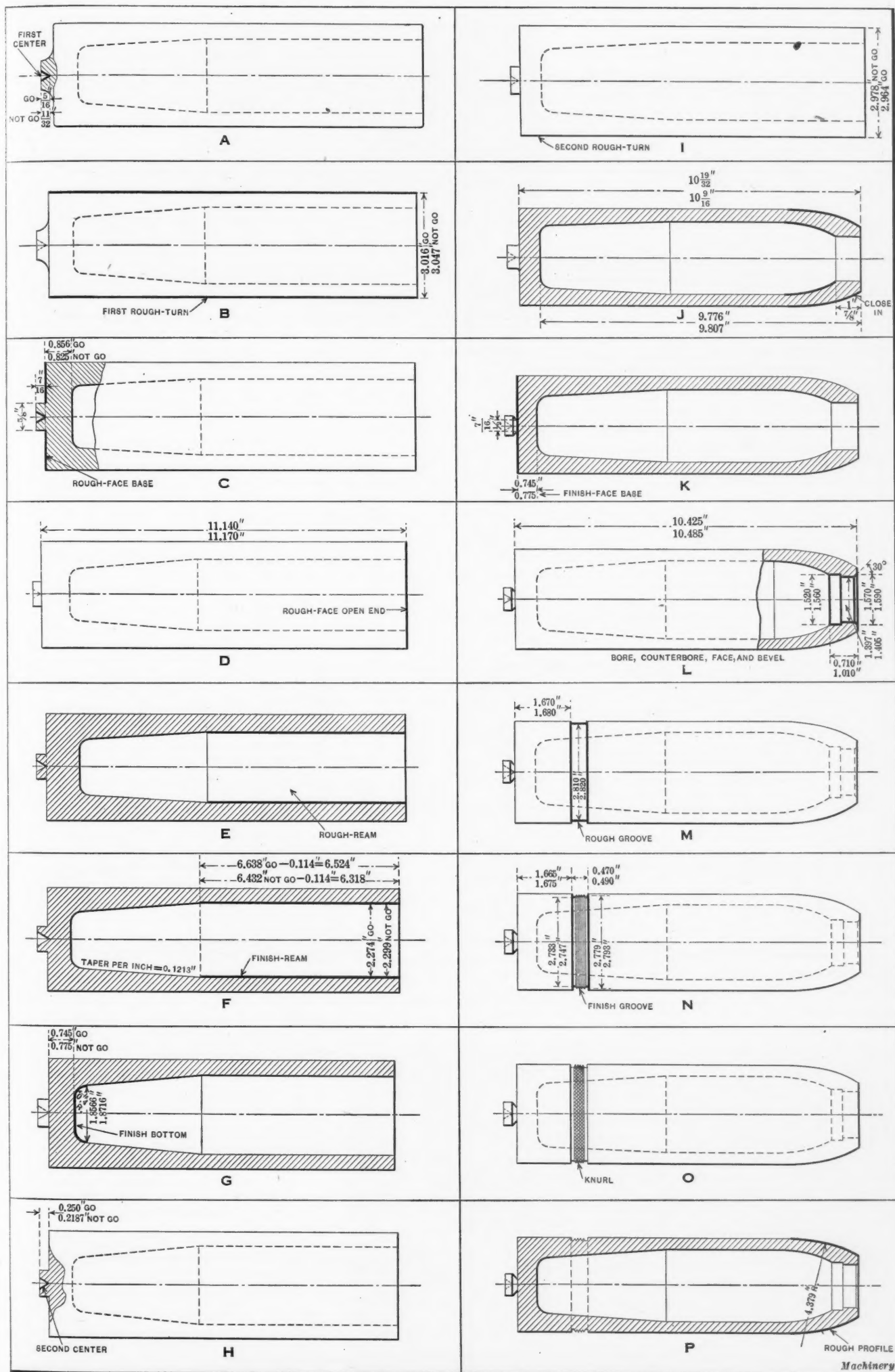


Fig. 8. Sequence of Machining Operations on United States 75-millimeter Shell

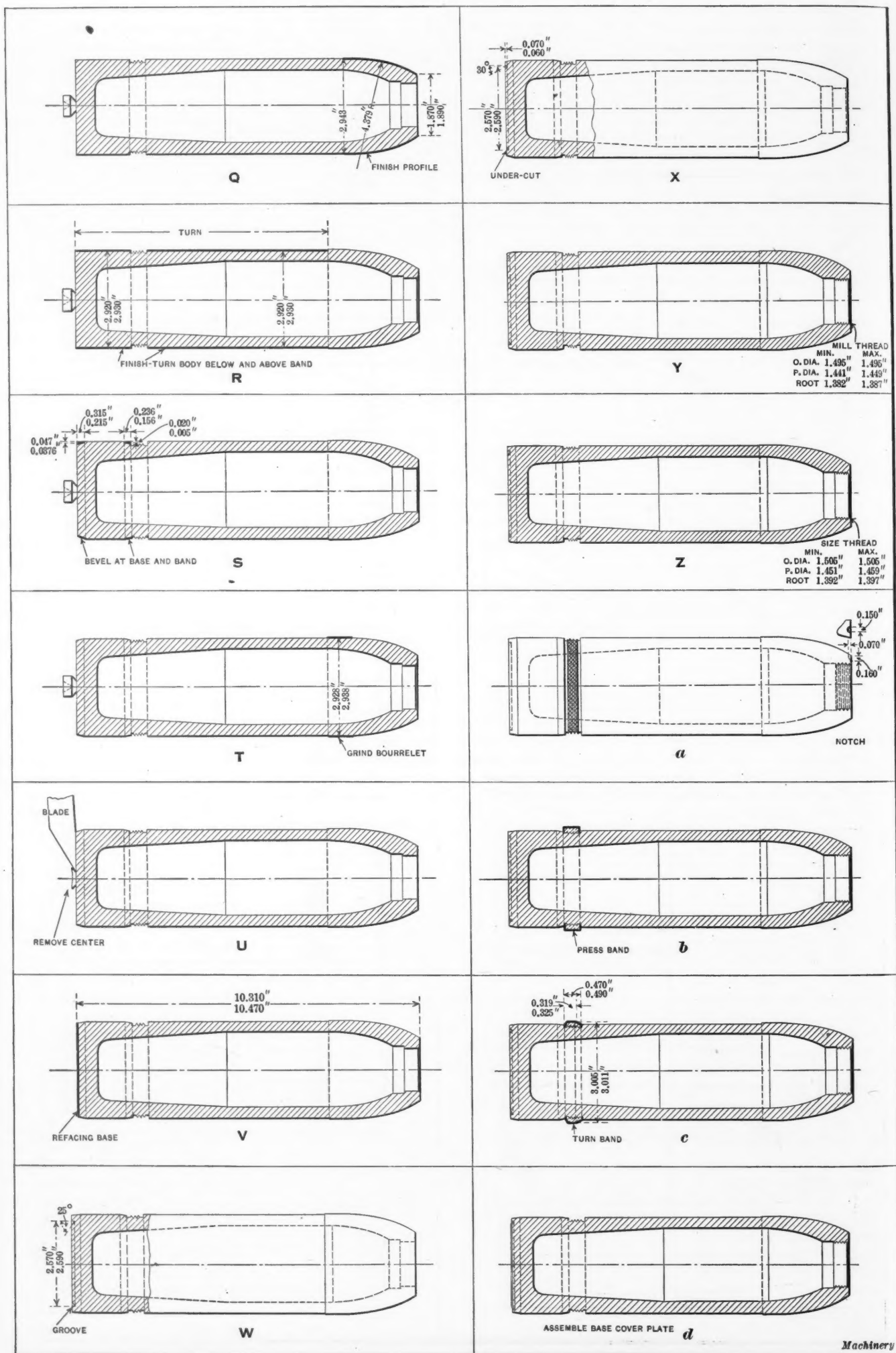


Fig. 9. Sequence of Machining Operations on United States 75-millimeter Shell—Continued

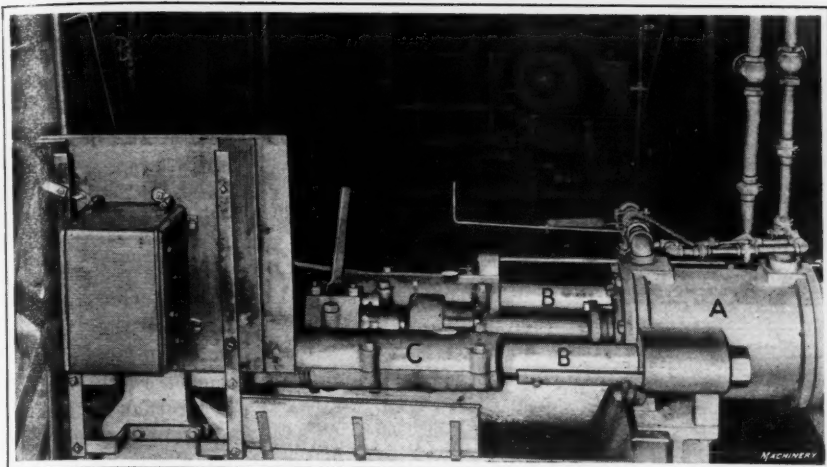


Fig. 10. Type of Hydraulic Machines used for rough-turning and facing Ends of Shells

from which the chips fall onto the conveyor belt below, which, in turn, is supported by concave idler pulleys as indicated. The return of the belt, of course, is supported by straight rollers.

Material Used for Shells

The shells are made from a low-carbon, open-hearth steel with a carbon content of from 0.40 to 0.50 per cent, and a

D and *E*, which operate the binding points, are moved outward. To release, air is admitted at the outer ends of the pistons.

Operation 4, the first rough-turning, is performed on a special hydraulically operated machine developed by the American Shell Co. This machine is shown in Fig. 10. It is provided with a hydraulic cylinder *A* of the duplex type, by means of which the center is hydraulically moved in and out of posi-

Machining Operations

In the following paragraphs a brief review of the machines and tools used for the machining operations that precede the heat-treatment will be given. The machining operations after heat-treatment, the gages used for inspection, and the inspection methods and tests to which the shell is subjected will be dealt with in subsequent articles.

The first centering, Operation 3, is performed in a lathe provided with a special pneumatically operated arbor for holding the shell while centering, as shown in Fig. 6. There are three points at each end of the arbor at *A* and *B*, which are pushed outward and hold the shells central. Part *C* of the arbor is held in the bearings of the lathe. Two pistons are provided, so that when the air is admitted between them the tapered sections

ORDER OF OPERATIONS ON U. S. 75-MILLIMETER SHELL

- | | | | |
|--|--|---|--|
| 1. Cut off on power hacksaw. | 20. Heat for hardening. | 37. Inspect finish-turning of nose. | 51. Inspect groove for base cover. |
| 2. Inspect for length. | 21. Quench in oil. | 38. Finish-turn body above groove for copper band. (<i>R</i>) | 52. Mill thread. (<i>Y</i>) |
| 3. Center. (<i>A</i>) | 22. Drain previous to tempering. | 39. Inspect previous finish-turning. | 53. Inspect milled thread. |
| 4. First rough-turning of entire outside. (<i>B</i>) | 23. Temper. | 40. Finish-turn body below groove for copper band. (<i>R</i>) | 54. Subject 10 per cent to hydraulic test. |
| 5. Inspect turning. | 24. Cool. | 41. Inspect previous turning. | 55. Size thread by tapping. (<i>Z</i>) |
| 6. Rough-face base. (<i>C</i>) | 25. Subject 10 per cent of shells to Brinell test. | 42. Bevel body for cartridge case. (<i>S</i>) | 56. Notch for detonator. (<i>a</i>) |
| 7. Inspection of base-facing for thickness. | 26. Finish base and under-cut boss for center. (<i>K</i>) | 43. Inspect beveling operations. | 57. Wash shells in oakite solution. |
| 8. Rough-face open end. (<i>D</i>) | 27. Inspect base and under-cut. | 44. Grind bourrelet. (<i>T</i>) | 58. Final shop inspection of whole shell. |
| 9. Inspect open-end facing. | 28. Bore, recess, face, and bevel hole for fuse. (<i>L</i>) | 45. Inspect grinding operation. | 59. Second government inspection of whole shell. |
| 10. Rough-ream inside. (<i>E</i>) | 29. Inspect previous operations. | 46. Remove boss for center by shearing. (<i>U</i>) | 60. Press copper band in place. (<i>b</i>) |
| 11. Finish-ream inside. (<i>F</i>) | 30. Rough and finish groove for copper band. (<i>M</i> and <i>N</i>) | 47. Reface base surface. (<i>V</i>) | 61. Turn copper band. (<i>c</i>) |
| 12. Finish inside bottom. (<i>G</i>) | 31. Inspect groove. | 48. Inspect refaced surface. | 62. Inspect copper band. |
| 13. Inspect entire inside. | 32. Knurl in groove. (<i>O</i>) | 49. Cut groove in base for cover. (<i>W</i>) | 63. Assemble base cover. (<i>d</i>) |
| 14. Recenter to make following operations concentric with inside. (<i>H</i>) | 33. Inspect knurling. | 50. Under-cut for base cover. (<i>X</i>) | 64. Press base cover in place. |
| 15. Second rough-turning of entire outside. (<i>I</i>) | 34. Rough-turn nose. (<i>P</i>) | | 65. Final government inspection. |
| 16. Inspect turning. | 35. Inspect rough-turning of nose. | | 66. Stamp number on shell. |
| 17. First government inspection of inside. | 36. Finish-turn nose. (<i>Q</i>) | | 67. Lacquer and dry. |
| 18. Heat nose for closing-in operation. | | | 68. Pack in cartons. |
| 19. Close in nose, or "bottle." (<i>J</i>) | | | |

manganese content of from 0.60 to 0.70 per cent. The specifications call for the following physical requirements: elastic limit, 45,000 pounds per square inch; ultimate tensile strength, 90,000 pounds per square inch; and elongation, 15 per cent in two inches. The reduction in area is not specified, but usually is from about 40 to 60 per cent. The shells must be machine-finished all over, and free from scale on the inside. The shell wall must be concentric within 0.030 inch, the bourrelet must be ground, and the base must be concentric with the band to within 0.005 inch, with the base cover securely fastened in place.

Order of Operations

The work is inspected after almost every machining operation, and the order of procedure in completing a shell, from beginning to end, including the inspection to which it is subjected, is given in the table. The appearance of the shell after the most important operations, and the dimensions, together with the required limits, are shown in Figs. 8 and 9. The letters in parentheses refer to the reference letters in these two illustrations.

tion and the tool carriage *C* is fed along by hydraulic power. The carriage is not mounted on a bed as in an ordinary lathe, but on two heavy rods *B* which connect the front and rear of the machine. The base is rough-faced in a machine designed

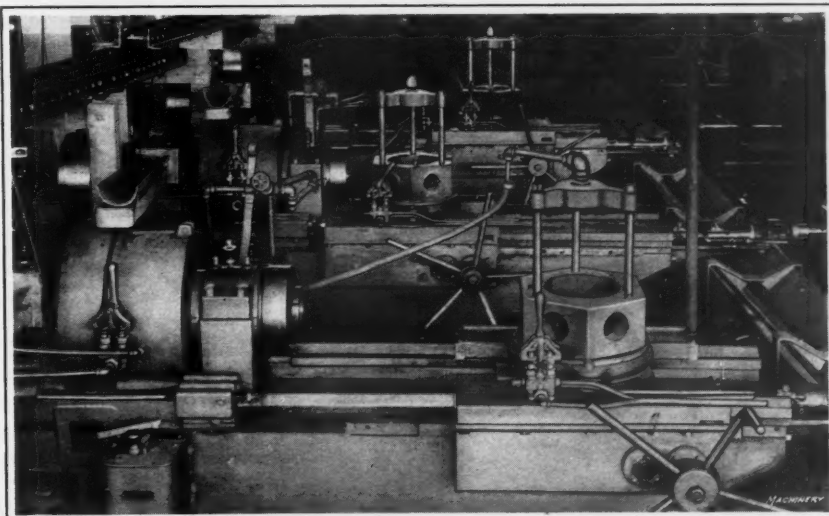


Fig. 11. Set of Three Machines for rough-reaming, finish-reaming, and finishing Inside Bottoms of Shells

very much along the same lines as that shown in Fig. 10. In this case, however, the carriage is provided with a lever-operated cross-slide, the lever being operated from the hydraulic piston-rod; this construction is diagrammatically illustrated in Fig. 7. The cross-slide *C*, carried on the connecting-rods *B* of the machine, is equipped with a special tool-block *D*, which holds two tools *E* and *F*, one of which faces the surface on the end and forms the boss for the center

while the other faces the boss. The rough-facing of the open end is done on the same type of machine as is used for facing the closed end, except that a regular parting tool is used.

Finishing Inside of Shell

The rough-reaming, finish-reaming, and finishing of the inside of the bottom are performed in sets of three machines, each placed side by side as shown in Fig. 11. These machines are specially designed by the American Shell Co., having pneumatically operated carriages. Referring to Fig. 11, the first machine rough-reams the shell; it is then passed to the second machine, which finish-reams it, and from there to the third machine, which finishes the inside bottom. For the rough-reaming operation a two-bladed reamer, as shown at *A* in Fig. 12, is used, and for the finish-reaming, a three-bladed reamer, as shown at *B*, is employed. The inside bottom of the shell is machined by means of a special tool-bar, as shown at *C*.

Fig. 11 shows in the upper left-hand corner a section of the gravity conveyors by means of which the shells pass to these machines. The operators put the shells in the holders shown while passing them from machine to machine in the same battery. On the right-hand side is a view of the chip con-

veyor, showing the trough into which the chips are shoveled and the belt that carries the chips away, which passes immediately beneath the trough.

Recentering and Second Rough-turning

After the inside has been finished, the shell is recentered in order that all subsequent operations may be performed on a center which is absolutely concentric with the finished inside of the shell. This recentering is performed on a machine of the same

type as that used for the first centering operation. After this centering, the shell is subjected to a second rough-turning, a 16-inch engine lathe being used for this purpose, provided with a special crank on the tailstock for rapid operation, the entire tailstock being moved quickly along the bed in this way. An expanding mandrel is used for the open end of the shell, the design of which is shown in Fig. 14. Three jaws *A*, moved outward by the tapered expander *B*, center and hold the open end of the shell, the other end being supported by the regular lathe center.

Nosing or "Bottling"

After the second rough-turning operation, the shells are nosed or "bottled"; that is, the open end of the shell is closed in to the pointed form required. Five heating furnaces, Fig. 13, are used for this work, each of which

has provisions for eight shells. The openings through which the shells pass into the furnace are water-jacketed, a casting, as shown at *A* in Fig. 15, having been inserted in the regular furnace opening. The shells project from this casting $2\frac{1}{4}$ inches into the furnace. As soon as the shell has become sufficiently heated, it is removed and placed in the nosing or "bottling" press. There are three of these presses, two of which are shown in Fig. 13, each one being able to close in three shells a minute. A nosing die *B*, in Fig. 15, is used for this work.

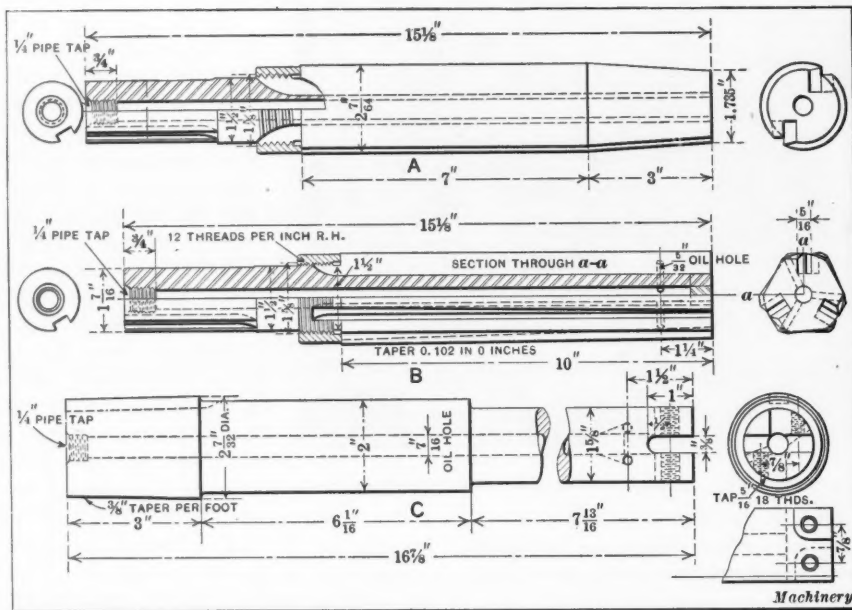


Fig. 12. Roughing Reamer, Finishing Reamer, and Inside Finishing Bar

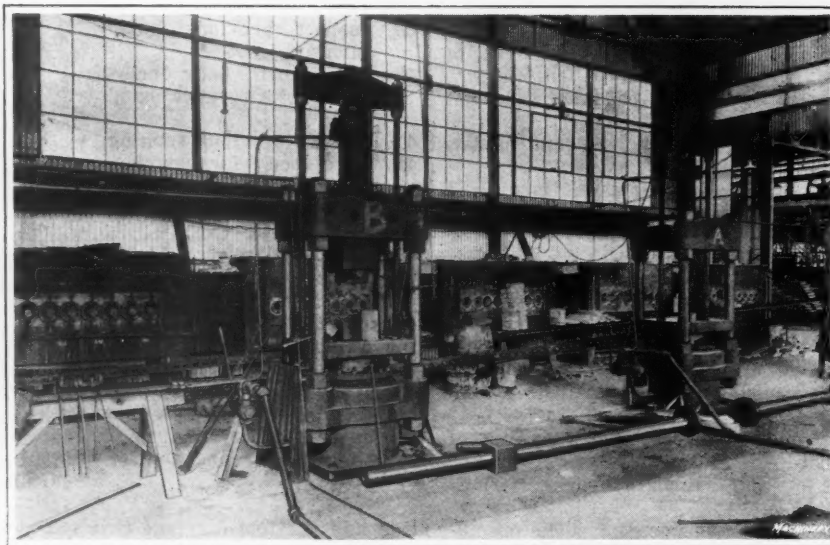


Fig. 13. Heating Furnaces and Presses for nosing Shells

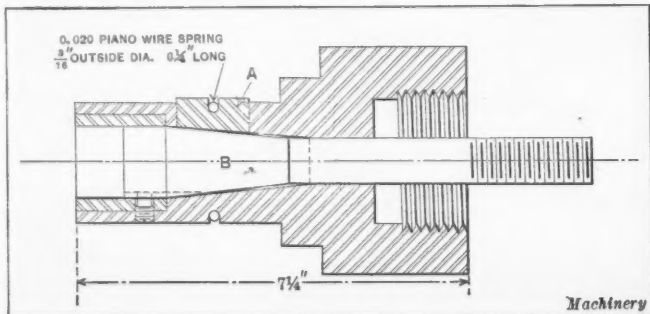


Fig. 14. Expanding Mandrel used in Second Rough-turning Operation

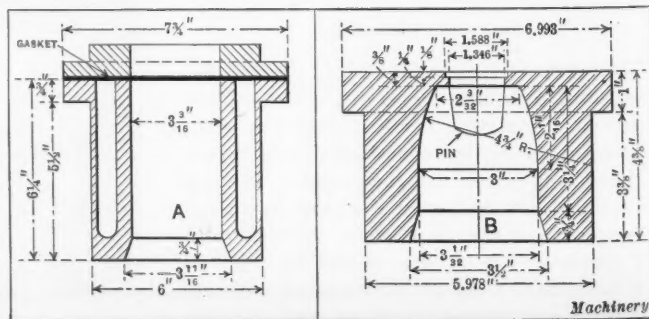


Fig. 15. Water Jacket for Nosing Furnaces and Die for Nosing Presses

WOMEN WORKERS IN MACHINE SHOPS IN GREAT BRITAIN

In a booklet published by the Merchants' Association of New York, relating to the readjustment and operation of industry in England since 1914, a report is given of labor conditions in Great Britain, the information having been obtained directly from a special commission from the British Ministry of Munitions which visited the United States in the latter part of the past year. As the United States can doubtless profit by the experience of Great Britain in regard to many, if not all, of the various problems connected with the war, some of the more interesting points brought out in the report referred to will prove of value in American industries. One of the most peculiar conditions in the British industries probably is that relating to the employment of women in machine shops, railroad shops, and other industries, where, in the past, men only were generally employed.

Sources from which Women Workers are Drawn

Women workers in industries have not been extensively recruited from the non-working class, as has often been believed in the United States. The patriotism of the British women has not, to any large extent, induced those not generally employed in gainful occupations to enter such employment. Instead, the supply of women workers has come from the non-essential industries, from small stores, from millinery and dressmaking establishments, from homes in which the bread-winner has been called into the army, and from the servant class. The best age for women who work on munitions has been found to be between twenty and thirty, and especially between twenty and twenty-five years of age. Their output generally compares favorably with that of men, and on shell work, except on the heavier types, the output from the women workers has been better than that of men.

Conditions of Work Due to Employment of Women

Practically no change in the machines on which the women work has been made, except that lifting appliances have been provided to an increased degree. Apart from the facilities for lifting heavy weights, little change in processes has been made necessary in the machine shops by the employment of women. The women work day and night shifts, the same as men. Generally, the women have not been segregated, except in a comparatively few cases. It has been found that in machine shops where men and women have been employed in separate departments, there is a slight increase in production, but not great enough to warrant separate departments, if the work does not readily admit of such an arrangement.

Frequency of Accidents

In many cases there has been a substantial decrease in the number of accidents resulting from the employment of women. Reports from many employers indicate that, since the introduction of women workers, accidents have been fewer and there has generally been less trouble from injuries. For instance, the operation of practically all cranes at the present time is done by women, who are more careful and cause fewer accidents. On the whole, it has been found that when working on dangerous work, women are more careful than men.

It was with extreme reluctance that women were employed on munition work in England. It was feared that the women's nerves would not stand the occasional explosions that are practically certain to happen in the manufacture of munitions. They appear, however, to stand these strains as well as the men. In one factory engaged in the manufacture of picric acid, a fire occurred in a department where both men and women were working. The men disappeared, and the firemen put out the fire with the help of the women. The women generally wear some kind of a working uniform. For any work where required, they wear trousers, and in machine shops they always wear caps over their hair to avoid accidents.

Labor Unions of Women Workers

Women had before the war two general unions of their own, which are now largely unions of munition workers. These

unions have gained greatly since the beginning of the war, and have been a source of assistance to the government. Since the war, women have also been admitted to the railway unions.

Women's Wages

It was agreed from the beginning that women undertaking skilled work should receive the same day rate as skilled men and the same piece rate. A woman's wage could differ from that of a man only when employed on unskilled or semi-skilled work; and then she came under an order which fixed the minimum wage at a rate which, in general, came to about two-thirds of the man's wages, varying with the district involved. The lower rate on unskilled work was due to the fact that women were found to be less effective on these general tasks, because on heavy lifting and such work it was found necessary to replace two men with three women. About from 30 to 40 per cent of the women employed work at the rate of two-thirds of men's wages.

The conditions of pay for women have not been particularly advantageous to employers directly, but indirectly they have been of great value. As a result of the good wages that women have been able to earn on munitions work, employers have never lacked applicants for almost every kind of work. At the present time the employment of women in England is limited only by the facilities for training them. As a further result of equal wages, the class of women taken into the munitions plants has been much above the class of the factory girl and the woman employed by textile works before the war. Women of good position and with fair education have been found, and this has undoubtedly had a great influence on the success of the employment of women in shops.

Work on which Women are Employed

Shell, fuse, grenade and similar repetition work of an easy type, calling for no particular accuracy, is obviously women's work as far as the operating is concerned; but there are now shops that employ women on nearly all the skilled work in shell factories. One factory, on light shells, employs about 94 per cent women. Taking shell, fuse and grenade work as a whole, the average number of women employed is about 80 per cent. On the skilled operations, such as howitzer work, the averages are not so high, but there are individual cases which show just as high a percentage of women employees. In the largest English explosive factory there are 15,000 employees, and of these, 11,000 are women. On trinitrotoluol manufacture the average is about 80 per cent women, and on picric acid the average is about 40 per cent. On filling fuses and similar classes of work, the average is generally well over 90 per cent. There are now in England over a million women working on munitions. They have undertaken work in every industry which has any bearing on munitions. Outside the machine shops, their work is largely laboring work, and they have undertaken laboring in every industry and under the worst possible conditions, even under such conditions as exist in blast furnaces, acid works, iron and steel plants, etc.

Training Required

For all simple repetition work, it has been found that women need no training at all, but for the more highly skilled work on howitzers, airplanes, engines, etc., the Ministry of Munitions has assisted the employers by equipping training schools. By far the greater part of the women on that work, however, have been trained in the factories themselves, but the smaller factories have found considerable difficulty in doing their own training, and in many factories there is too little work of this nature on which women can gradually acquire skill. The ministry has, therefore, organized two classes of training establishments—training schools attached to various technical colleges that exist in most industrial centers, and factories taken over by the ministry equipped as instructional plants. They do actual munition work in these training establishments. They do not attempt to give general training, but they give specialized training on a specific type of machine, and in that way the women acquire a considerable degree of skill in a period of from six to eight weeks. On the whole, this has proved very satisfactory.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

Fred E. Rogers, for nineteen years editorially connected with MACHINERY, and for eleven years its editor, has retired from that position to again take up mechanical constructive work. His first undertaking will be the development of a line of special machinery. In retiring, Mr. Rogers takes with him the good wishes of everyone connected with MACHINERY in all its departments.

Erik Oberg, who has been an associate editor of MACHINERY since 1906, becomes the editor with the current number. Mr. Oberg was born and educated in Sweden, and is a graduate of Boras Technical College. After some practical shop experience in that country he came to the United States in 1901 and entered the employ of the Pratt & Whitney Co. at Hartford, where he remained for five years, except for a short period spent with the Cincinnati Milling Machine Co. Mr. Oberg's widely varied practical experience has formed the basis of many articles on mechanical subjects published in MACHINERY since 1906, and for a "Handbook of Small Tools" published in 1908. For several years Mr. Oberg has had editorial charge of MACHINERY's book publications, and is well known as the editor of MACHINERY'S HANDBOOK and MACHINERY'S ENCYCLOPEDIA.

PREVENTABLE WASTE OF COAL

Two hundred and fifty million dollars a year is going to waste through improper operating methods in boiler plants. By the introduction of proper methods, ten per cent of all the coal now burned for steam-raising purposes might be saved. Such a saving would release for other service freight car space equal to the total coal-carrying capacity of the Pennsylvania Railroad east of Pittsburg. The above statements were made by David Moffat Myers in a paper read at the annual meeting of the American Society of Mechanical Engineers. Investigations made in one steel mill, he also declared, showed that it was possible to save, in the boiler furnaces of that mill alone, 40,000 tons of coal yearly. Yet the plant in question was comparatively modern in its methods. There are many more extreme cases.

In one hand-fired plant the steam evaporation was raised from six to nine pounds per pound of coal by simply giving a few days' instructions to the employees. The saving or wast-

ing of one-quarter of the coal consumption at an industrial plant depends entirely on the efficiency of its operating management. Yet, under present conditions, a plant operated carelessly at an efficiency of from 40 to 50 per cent receives the same consideration in the delivery of coal as a plant having an efficiency of from 70 to 75 per cent. This is unfair. If food products were thrown away as fuel is at hundreds of plants, public condemnation would smite the delinquents without delay. Yet waste of coal is, perhaps, more dangerous than waste of food.

Waste of fuel in power plants may be prevented in two ways: by enforcing upon coal consumers measures of economy, or by inculcating patriotism as a motive and emphasizing the advantages to be derived from coal saving. Coal users will probably make many objections to the first plan; yet, were it once put into effect, most of them would doubtless realize its pecuniary value to themselves. Were the second method to be adopted, the necessary educational work might be undertaken by the American Society of Mechanical Engineers, and by the United States Bureau of Mines and other government agencies.

* * *

FACILITATING WAR WORK BY PUBLICITY

Cooperation in every branch of war activity is essential to success in modern warfare; cooperation between the various establishments in the United States making similar munitions of war is the keystone of victory. To secure such cooperation there is no better way than to give widespread publicity to the processes used in munition manufacture, so that the best of them may be widely adopted and those found unsatisfactory discarded. Great Britain points the way for us in this phase of cooperation. The headquarters of the British Ministry of Munitions of War in the United States has issued a booklet of instructions for the gaging and inspection of screw threads. It describes the apparatus that has been found most accurate and useful. It gives the information and formulas required by inspectors of thread gages and screw threads in general. It is a booklet that should be imitated by the War and Navy Departments of the United States in order to facilitate the manufacture of all kinds of war materials.

Why should not the United States Government have competent engineers, with experience in recording technical data for publication, study the methods of manufacture and inspection used in making the different classes of arms and munitions required for the American Army? Having obtained and classified the data, the Government could then place in the hands of every manufacturer with whom it closes a contract a set of instructions for the particular work to be done, based on the reports received from its engineers. In this way the methods employed in some plant already manufacturing the kind of munitions desired, which, from the reports of the engineers, had been adjudged the best methods for that kind of work, could be brought to the attention of other manufacturers about to engage in munition making, and the result would be that the materials needed by the Government could be manufactured much more rapidly than if each concern should be compelled to work out its own methods without such valuable guidance.

The Government, of course, is too busy just now to publish a great many booklets of this kind. It should do the next best thing, which is to cooperate with the engineering journals of the United States, allowing them to study methods of manufacturing war material in shops designated by the Government as embodying a high standard of accuracy and efficiency. With these facilities at their disposal, the engineering journals could record, for the benefit of all manufacturers working on a certain class of war material, information that would tend to improve the quality and increase the quantity of their output. In a crisis like the present there is nothing to be gained by secrecy regarding manufacturing processes. Publicity of methods used in the manufacture of war materials will help win the war, and that, after all, is the main thing. MACHINERY places its editorial staff at the disposal of the Government, if aid of the kind outlined above should be required.

VALUE OF TRADE JOURNAL ADVERTISING TO ENGINEERS AND DRAFTSMEN

BY C. C. MARSH¹

The advertising section of the engineering trade journals constitutes a valuable source of information for engineers and draftsmen; but the value of this material depends entirely upon the manner in which it is collected and classified. In plants that must improve their products from year to year, in order to be able to compete with their rivals, many changes in design call for improved and even entirely new methods of machining, requiring new types of machine equipment from the machine tool manufacturer. The new ideas thus created, taking the form of new machines, are recorded in the advertising pages of the trade journals, and a complete file of these, classified so that any one of them may be easily found, will be of great value to both the engineer and the draftsman. These men, therefore, should observe, read, and take note of really good and valuable data written in the form of advertisements. There are many clear illustrations and much useful information to be obtained. Trade journal advertising always precedes the manufacturers' catalogues; in fact, it is first-hand information.

The machine shop foreman is the one who generally calls the engineer's or draftsman's attention to some new idea in machine tool equipment. Being more directly concerned with production, he is the one who is looking for such information, and who reads these advertisements most carefully. He is also the one whom the purchasing agent asks for specifications before buying. The machine shop foreman often remarks, "I could turn out these parts in larger quantities and with greater accuracy if I had up-to-date tools like these," pointing to an advertisement. He keeps in touch with the progress in the development of machine tools and he watches closely the advertisements of manufacturers.

That filed and indexed information and records of machine tool advertisements is labor well spent is easily proved. After a plant in the Middle West obtained a contract for war munitions, in which time was one of the essential factors, it found that it did not have the proper machine shop equipment to make the parts accurately enough to pass the government inspection; it also found that to meet some of the requirements the new equipment must be of the most improved design. Machining operations were called for in which the plant had had no experience. During a meeting of the executives a draftsman, who had on several occasions furnished the purchasing agent with machine tool specifications, was called in. Someone soon noticed that he constantly referred to a notebook and asked what the book contained. The draftsman thereupon placed the book on the table saying that it was an indexed list of modern machine tools and their manufacturers that he had made up during his spare moments; in addition, he had tried to make note of some special improvement. He then showed them a page, which read as follows:

Tapping Attachment for Drill Press

John Smith & Co.,
Smithstown, N. Y.

Features: Fits drill presses from small sensitive type up to largest radial. See cuts and advertisements in *Manufacturer's Review*, issue July 14, '17.

By means of this index he said that he could immediately find the advertisement of any particular kind of machine tool or attachment therefor, as he kept all copies of the different trade journals for which he subscribed that contained any advertisements of new tools or improvements on old ones. Recognizing at once the value of this index, the chief engineer asked him to make a list of machine tools as the various operations to be performed on the different parts were mentioned, which the draftsman did, and the next morning he gave it to the chief engineer with the advertisements attached. As a result, by noon letters had been mailed to the various manufacturers for catalogues, specifications and quotations, together with delivery dates. Thus much time was saved and one requirement of the contract was complied with at once.

Another firm in the same locality was working on a government contract, when the government engineers found it neces-

sary to change the design of one of the parts, and, as often happens, this caused changes in several of the other parts. Work had proceeded to the point of starting the tool-room on the making of the fixtures, although some of the latter had not been drawn when the firm received a message that some changes were necessary. It immediately stopped work in the tool-drafting department on the designing of the jigs and fixtures, hoping to receive the changed instructions within a few hours. The chief tool designer, not wishing to see his men idle, handed each one a machinery trade journal with instructions for its use. Shortly afterward the superintendent and the chief engineer entered the room. When the former noticed that the tool draftsmen were diligently reading the magazines, he said to the chief tool designer: "Nice way to spend time, especially government time. What's the idea; do you think this is a good place to start a class in reading, or perhaps you think this is a public library? Why are those fellows spending their time like that?"

"While we are waiting for information concerning these changes, I thought that I could keep the men busy obtaining some useful data on tool design," answered the chief tool designer. "You see, each of these men is working on the design of a different fixture for the same part. So when we received orders to stop work temporarily, I gave each one a trade journal with instructions to find the advertisement of a machine similar to the one on which the jigs they were drawing would be used, and pick out some idea that they could incorporate into the drawing they were making, and to see if other ideas would not be suggested by the cuts and pictures. I think that this is a better idea than to send them home for the rest of the day. Besides, looking over the various advertisements whets their interest, while idleness doesn't."

There are many other little incidents that could be related, but these show that the valuable data printed in the form of advertisements, together with many clear illustrations, a great number of which are made from actual photographs, can be used often and well if properly classified. It is interesting to note that all classes of mechanical men realize more and more the value of trade journal advertising and that it is no longer only those who are directly interested in the buying that read these pages.

* * *

CARE OF SCREW THREADS WHEN ERECTING MACHINERY

The erector of machinery can make repairs difficult or comparatively easy, according to the care taken, when inserting studs and screwing on nuts, to lubricate the threads with an oil or compound that prevents rust. The careless erector gives little or no thought to the problems of the men following him, who at some future time will be called upon to take the machine down and repair broken or worn parts. If studs, bolts, screws and nuts are set up dry, or lubricated with a thin oil that soon evaporates and leaves the threads unprotected, the inevitable result is rusting and seizure of the threads. When the repair men undertake to dismantle the machine, the "seized" nuts have to be split and rusted bolts have to be drilled out, thus delaying progress and increasing the cost of the repairs.

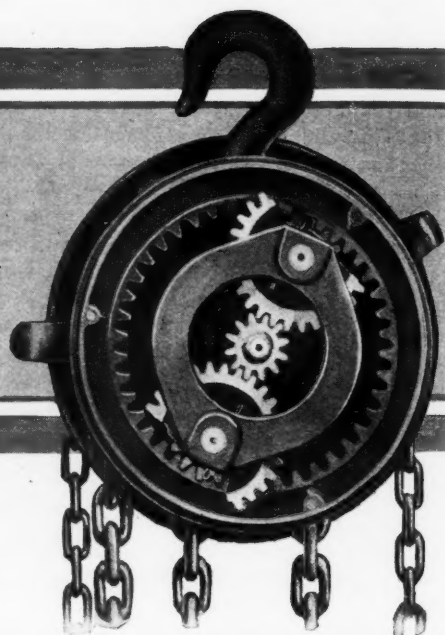
When erecting machinery, especially steam, oil, and gas engines, it is good practice to use machine oil mixed with graphite on all screws, especially those securing the cylinder heads, valve chambers, and covers. Graphite affords a peculiarly efficient protection for metal surfaces. Studs whose threads are covered with graphite may be in use for years on steam engines, and the nuts will loosen readily when repairs are needed. The importance of erecting machinery so that repairs can be made quickly in time of need is emphasized in war times. The designer may carefully lay out and plan a machine to secure long life and high efficiency, but the best machinery must occasionally be overhauled, and it is then that the work of the erector assumes the greatest importance, especially if an emergency arises. If the threaded parts can be easily removed, the probability is that the machine can be repaired and re-assembled with a minimum of expense and trouble.

¹Address: 1338 Barth Ave., Indianapolis, Ind.

Differential Motions and Planetary Gear Combinations

By Franklin D. Jones¹

First Installment of a Treatise on Mechanisms that Require Differential Motion and Methods of Determining Relative Velocities of Planetary or Differential Gears²



A DIFFERENTIAL motion may serve to greatly reduce the movement of a driven member in a train of mechanism, either for the sole purpose of securing a relatively small motion or adjustment, as in the case of the differential screw, or as a means of increasing the power or lifting capacity by sacrificing speed, as, for example, when utilized in connection with the differential hoist to be described. A mechanism capable of differential action may also be used to transmit motion between two driven parts, in order that they may operate either in unison and at the same speed or independently and with the speed of either part ranging from zero up to the maximum, as may be required by variable operating conditions. The application of the differential principle has often made it possible for machine designers to accomplish by mechanical means what would otherwise have been impracticable or entirely impossible. Some of the more important forms of mechanisms which have a differential action will be described to illustrate the practical application of this principle in machine construction.

Differential Screw and Hoist

The differential screw, which is a simple example of a differential motion, is a compound screw from which a movement is derived that is equal to the difference between the movements obtained from each screw. The diagram A, Fig. 1, illustrates the principle. A shaft has two screw threads on it at *e* and *f*, respectively, which wind in the same direction but differ in pitch. Screw *f* passes through a fixed nut, and screw *e* through a nut that is free to move. The motion of the movable nut for each revolution of the screw equals the difference between the pitches of the threads at *e* and *f*. This combination of screws of different pitch makes it possible to obtain a very slight motion without using a screw having an exceptionally fine pitch and a weak thread. Another form of differential screw is shown at B, which illustrates a stop that enables fine adjustments to be obtained readily. The screw bushing *g* is threaded externally through some stationary part and is also

threaded internally to receive screw *h*, which is free to move axially but cannot turn. Both screws in this case are right-hand, but they vary as to pitch. If bushing *g* has a pitch of 1/32 or 0.03125 inch and screw *h* a pitch of 1/36 or 0.02777 inch, one complete turn of *g* will advance screw *h* only 0.00348 inch ($0.03125 - 0.02777 = 0.00348$), because, as bushing *g* advances 1/32 inch, it moves screw *h* back a distance equal to the difference between the pitches of the two threads. By turning the bushing only a fractional part of a turn, very small adjustments may be obtained.

The Chinese windlass shown by the diagram C, Fig. 1, is another simple example of a differential motion. The hoisting rope is arranged to unwind from one part of a drum or pulley onto another part differing somewhat in diameter. The distance that the load or hook moves for one revolution of the compound hoisting drum is equal to half the difference between the circumferences of the two drum sections. The well-known differential chain hoist illustrated at D operates on the same general principle as the Chinese windlass. The double sheave *a* has two chain grooves differing slightly in diameter, and an endless chain passes over these grooves and around a single pulley *b*. Pulley *b* and the hook attached to it is raised or lowered, because for a given movement, a greater length of chain passes over the larger part of sheave *a* than over the smaller part. If the upper sheave is revolved by pulling down on the side *d* of the chain that leads to the groove of smaller diameter, the loop of chain passing around pulley *b* will be lengthened, thus lowering the pulley; the opposite result will be obtained by pulling down on the side *c* of the chain, which

leads up to the larger diameter of the sheave.

Differential Motion between Screw and Nut

Variations of movement are sometimes obtained by the differential motion between a revolving screw and a nut which is rotating about the screw at a different speed. One application of this principle is illustrated by the variable-speed mechanism of a milling machine shown in Fig. 2. This mechanism is designed to increase the efficiency of a machine by accelerating the speed of the table when the cutters are not at work. The machine table moves rapidly up to the cutting point, then the

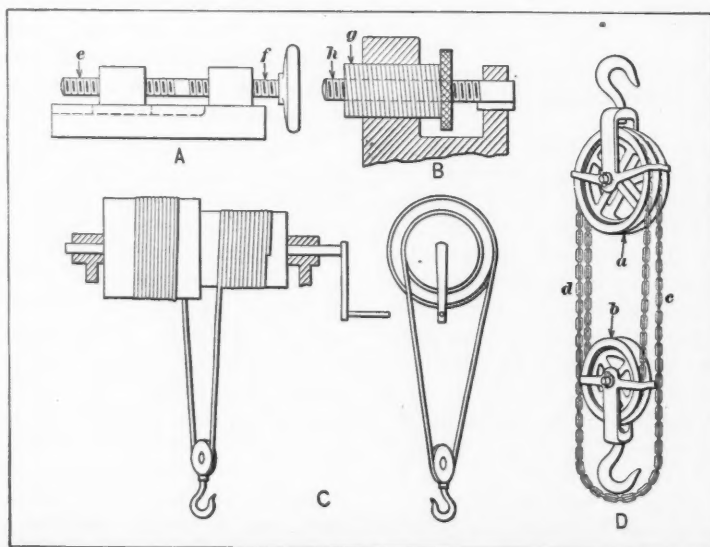


Fig. 1. (A) and (B), Differential Screws; (C), Chinese Windlass; (D), Differential Hoist

¹Associate Editor of MACHINERY
²A chapter that will be included in the author's book "Mechanisms and Mechanical Movements," to be published in the near future

speed is reduced while milling, and, after the operation is completed, the table is quickly returned to the loading position.

This mechanism is located beneath the machine table *C*, which is traversed by a screw *D* that passes through the plain bearings *E*, *F* and *G*, mounted upon the base of the machine. The pinion *H* is confined longitudinally between bearings *E* and *F*, and it is splined to screw *D*, so that the latter must turn with the pinion but is free to slide in a lengthwise direction. The hole through

gear *I* is threaded to fit screw *D*, so that it is practically a nut and gear combined. The auxiliary shaft *J*, supported in bearings *K*, carries two pinions *L* and *M*, which are loosely mounted upon the shaft. This shaft *J* is rotated continuously in one direction through spiral gears *W* from the driving shaft *V*. Within the housings *N* and *O* are clutch sleeves which encircle the shaft *J*. The sleeves are splined to the shaft, but are free to slide upon it, and they may be locked with teeth formed on pinions *L* and *M*. These clutches are controlled by levers *T* and *U* at the front of the machine, which are connected by the shafts shown, with the clutch shifting devices at *R* and *Q*. The action of the clutches is controlled automatically by adjustable stops located on the front of the machine table.

The clutch connecting with gear *L* is first engaged by hand-lever *T*. The table then moves forward rapidly (in the direction indicated by arrow *A*) as gear *H* revolves screw *D* and causes it to turn through the gear nut *I*, which is held stationary at this time. Just before the milling cutter begins to act upon the work, lever *U* strikes a stop, thus engaging the clutch with gear *M*. The gear nut *I* is then revolved in the same direction as gear *H* but at a slower speed, so that the differential action between the screw and nut. Both sets of gears continue to operate while the cut is being taken; when the milling operation is completed, another stop engages lever *T*, thus stopping the rotation of gears *L* and *H*. As the gear nut *I* continues to revolve about the screw, the movement of the machine table is reversed, since screw *D* is not rotating. The motion continues in the direction indicated by arrow *B* until a third stop to the right of lever *U* trips the latter, thereby stopping gear *I* and the table movement. The table is now in position for removing the finished parts and replacing them with others that require milling.

Differential Motions from Planetary Gearing

Most differential motions are derived from combinations of either bevel or spur gearing. In some applications, all the gears of the train revolve as a unit and without any differential action, except when such action is essential to the operation of whatever machine or mechanism the gearing forms a part. Combinations of gears arranged to give a differential motion are known either as planetary gearing, epicyclic gearing, or as differential gearing. The term "planetary gearing" is, of course, based on the similarity between the motion of a gear or pinion revolving about another fixed gear (which is common

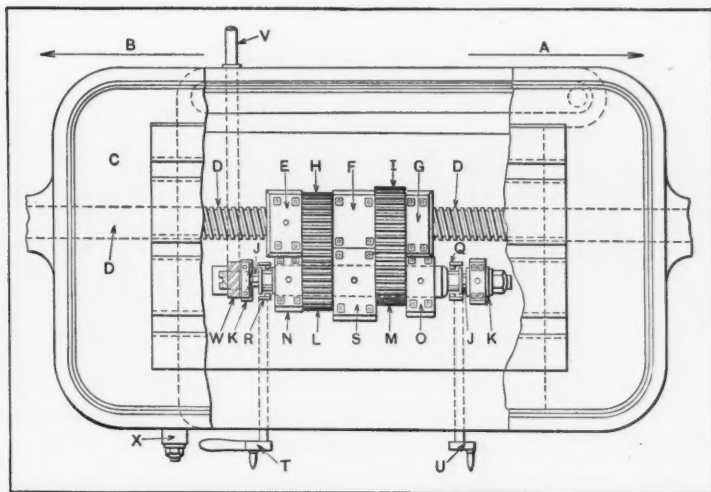


Fig. 2. Variable Feeding Mechanism partly controlled by Differential Movement between Revolving Screw and Nut

indicates the differential action and is almost invariably applied to some planetary gear combinations, as, for example, those applied to automobiles and to certain classes of textile machinery.

The planetary bevel gear train illustrated by diagram *A*, Fig. 3, is applied to many mechanisms of the differential type, and its action under different conditions should be thoroughly understood. The shaft *a* has mounted on it two bevel gears *b* and *c* and an arm *d*. The arm is attached to the shaft and carries a pinion *e* which meshes with each gear and is free to revolve upon the arm. There are several conditions that can exist with a gear train of this kind.

First, assume that gear *b* is stationary and *c* loose on the shaft. If the shaft and arm *d* are revolved, motion will be transmitted from the stationary gear *b* to gear *c*, through pinion *e*, and gear *c* will make two turns for every one of arm *d* and in the same direction as the arm. If gear *b* should rotate instead of being stationary, this motion, combined with that of the arm, would modify the motion of gear *c*, and it would also make a difference whether gear *b* turned in the same direction as the arm or in an opposite direction.

Second, suppose the preceding conditions are reversed and one of the bevel gears *b* or *c* is revolved while the other gear remains stationary, and that arm *d* carrying the bevel pinion constitutes the driven element. With only one gear revolving, the arm will turn in a direction corresponding to that of the gear and at half its speed. If both gears rotate in the same direction at different speeds, the arm will follow in that direction and with a speed intermediate between the two. If the gears are driven in opposite directions at different speeds, the arm will follow the more rapidly moving gear, and if the speeds are equal, pinion *e* will revolve upon the arm, but the latter will remain stationary.

Third, assume that arm *d* remains stationary and gears *b* and *c* are loose on the shaft. If gear *b* is the driver, pinion *e* will simply transmit motion to gear *c* in the opposite direction, the three gears in this case forming a simple train with pinion *e* acting as the idler. The force tending to rotate arm *d* will be one-half the force transmitted from gear *b* to gear *c*.

A practical application of this last principle is found in the Webber differential dynamometer. The arm of this dynamometer which supports the scale pan and weights corresponds to arm *d* and is pivoted on a shaft carrying two bevel gears. On the arm and meshing with these two bevel gears are bevel pinions, and the amount of power transmitted through this train of gearing is measured by the weights in the scale pan. The combination of gear-

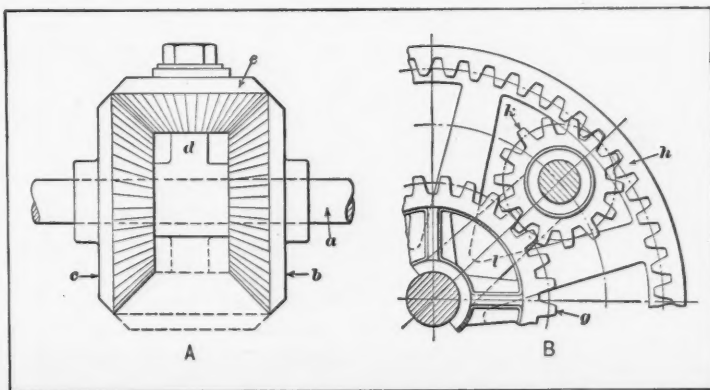


Fig. 3. Planetary Trains of Bevel and Spur Gearing

ing illustrated by diagram A usually has two or more pinions meshing with the bevel gears. In many cases, there are two pinions located diametrically opposite, as indicated by the full and dotted lines. The addition of other pinions, however, does not affect the action of the gearing.

The diagram B, Fig. 3, shows an arrangement of planetary spur gearing. This combination consists of an ordinary spur gear *g*, an internal gear *h*, and a pinion *k*. This pinion is free to turn on a stud that is attached to arm *l*. In the application of this gearing, there are three possible conditions. In the first place, the internal gear *h* may be stationary, and the gears *g* and *k* may revolve. Second, the arm *l* may be stationary, in which case either the internal gear *h* or gear *g* may be the driver. Third, gear *g* may be stationary and the motion transmitted in either direction between gear *h* and arm *l*. Fig. 4 shows a practical application of this gear combination. In this design, there are two intermediate pinions (corresponding to *k* in diagram B, Fig. 3), which are mounted on an arm and located diametrically opposite each other. This arm is keyed to the end of a shaft. The large internal gear is stationary and forms part of a casing enclosing the gears. The central gear is keyed to another shaft which is in line with the shaft carrying the pinion arm. This arrangement is simply used to obtain a reduction of speed. The design is compact, although differential or planetary gearing, in general, is inefficient as a transmitter of power. Such gear combinations, however, have certain mechanical advantages, and they are often utilized by designers for a variety of purposes, as indicated by the different mechanisms to be described.

Differential Governors for Water Turbines

Many of the automatic governing devices used for controlling the speed of water turbines have a differential action. A simple form of governor is illustrated in principle by the diagram A, Fig. 5. An auxiliary water motor drives the bevel gear *a* by belt *d*, and bevel gear *c* is driven by belt *e* from a shaft operated by the turbine to be governed. Both gears *a* and *c* are loose on their shaft, but the arm *n* which carries the bevel pinions *b* is fast to the shaft. On one end of the shaft there is a pinion *f* which meshes with a rack *g* that operates the turbine gate, and thus controls the flow of water to the turbine. The auxiliary motor has no work to do except to drive part of the governing mechanism, and it runs at practically a constant speed. The variations due to the rise or fall of the water level are so small a percentage of the total head of water that the speed of this motor is little affected. It will be assumed, then, that the speed of gear *a* is practically uniform. The speed of gear *c*, however, changes with an increase or decrease of the load upon the turbine, and, as gear *c* runs faster or slower than gear *a*, the arm *n* follows it around one way or the other, and in this way opens or closes the turbine gate.

The governor shown at B also has a differential action, but it is controlled by centrifugal force acting on a fly-ball governing device. The governor is operated by a belt *a* connected with

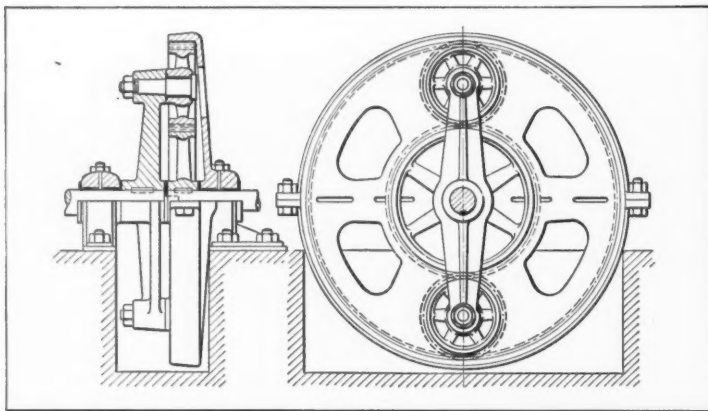


Fig. 4. Planetary Gearing for obtaining Speed Reduction

the turbine. This belt passes around idler pulleys and over the wide-faced pulleys *b* and *c*. These pulleys, through bevel gearing, drive the differential gearing composed of gears *d*, *e* and *f*. Gears *d* and *e* are loose on their shafts and pinion *f* is pivoted on an arm that is keyed to the shaft. Gear *e* is connected by the gearing shown with a centrifugal governing device at *g*. The belt pulley *b* is conical and the diameter at the center is the same as that at pulley *c*. When the turbine is operating at normal speed, the belt is at the center of the conical pulley *b* and, consequently, gears *d* and *e* revolve at the same rate of speed in opposite directions. The result is that the arm carrying pinion *f* remains stationary. If the turbine begins to run too fast, the balls at *g* move outward under the action of centrifugal force, and belt *a* is shifted by a mechanism (not shown) to a smaller part of the conical pulley *b*. The resulting increase in the speed of gear *d* causes the arm carrying pinion *f* and the shaft *h* to which it is attached to revolve in the same direction as gear *d*. As a result of this movement, the turbine gate is lowered by means of gearing (not shown), and the speed of the turbine wheel is reduced. If the turbine should begin to run more slowly than the normal speed, the shifting of belt *a* by governor *g* would cause gear *d* also to revolve slower, thus turning shaft *h* in the opposite direction and raising the gate.

Another modification of the differential governor is shown by the diagram Fig. 6. This particular type of governor was installed in one of the large power plants at Niagara Falls. It is equipped with two sets of epicyclic gearing. The gears *A* and *B* are free to turn on the shaft, but may be retarded by brake bands at *E* and *F*. The inner gears *C* and *D* are driven by belts connected in some way with the turbine. One of these belts is open and the other crossed, so that the gears revolve in opposite directions. The brake bands are so arranged that, when one tightens, the other loosens its grip on the brake drum. Both of these bands are operated by a shaft *G*, and the tightening of the bands is effected by a double ratchet mechanism (not shown) having two pawls. One pawl rotates shaft *G* in one direction and the other in the opposite direction. When the speed increases or decreases, one pawl or the other is operated by a fly-ball governor driven from the turbine. As the result of this motion of the pawl, one band is tightened and the other released, so that one of the gears *A* or *B* is held with a greater or less degree of friction or is prevented from turning altogether, while the other one runs free. If gear *A* is held by the brake, the arm carrying pinion *H* will begin to turn in the same direction in which gear *C* turns, whereas,

if gear *B* remains stationary, the arm carrying pinion *J* will follow gear *D*; consequently, the pinion *K* on the end of the shaft will, by means of a rack, raise or lower the turbine gate. This governor depends for its sensitiveness upon the fly-ball governing device, and for its power upon the open and crossed belts, which may be proportioned to transmit any required amount of power.

Compound Planetary Gears for Varying Speeds

The planetary speed-changing mechanism shown in Fig. 7 has spur gears

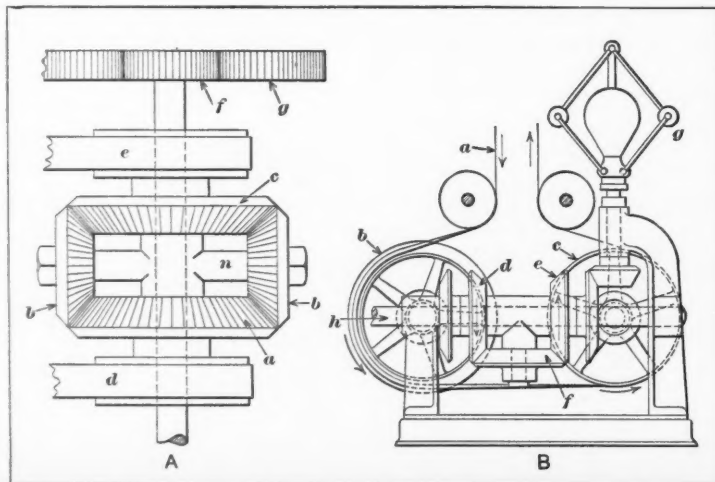


Fig. 5. Differential Governing Devices for Water Turbines

and pinions but no internal gear. This is a compound or reverted train and is intended for an automatic screw machine of the heavier class (the Cleveland), in order to provide a slow and powerful movement to the spindle for heavy thread-cutting operations, or for any other heavy work that requires a powerful drive. The gearing is contained within the spindle-driving pulleys on the back-shaft of the spindle head. There

are three pulleys, and the slow speed is obtained by shifting the belt to the center pulley A, and engaging the sliding clutch B with gear C; as this clutch slides upon a square shaft and cannot revolve, the gear C is held stationary. There are two sets of planetary pinions D and E located diametrically opposite each other. The pinions on each stud are locked together but are free to revolve about the stud. Pinions D rotate around the fixed gear C, while pinions E revolve the driven gear F at a slow speed, but with considerable power. Gear F is keyed to the extension of pinion G, which meshes directly with the front spindle gear of the machine. When this slow speed is not required, clutch B is disengaged, so that the entire train of planetary gears is free upon the loose center pulley A. Two spring plungers (not shown) attached to pulley A engage the rim of pulley L and cause both pulleys to revolve together when the slow-speed attachment is not engaged, so that the planetary pinions will not revolve upon their studs at this time. Clutch B is shifted by a cam-operated rod H acting in conjunction with a spring J.

With this arrangement of gearing, the differential action and reduction of speed is the result of the difference in the diameters of pinions D and E and their mating gears. When the slow-speed attachment is operating, the larger pinions D roll around the stationary gear C and force gear F to follow slowly in the same direction. This action will be more apparent if that part of the larger pinion D which is in engagement with stationary gear C, at any time, is considered as a lever pivoted at the point where the teeth mesh with the stationary gear. As the pinion D revolves and the imaginary lever swings around its fulcrum, the teeth of the smaller pinion E in contact with gear F force the latter to move in the same direction in which the rolling pinions D and E and pulley A are moving.

Planetary Gearing Combined with Cone Pulleys

The use of a cone pulley and planetary gearing is shown at A, Fig. 8. The cone pulley has a pinion a, which meshes with pinion b, mounted on a stud carried by plate c. Pinion b also meshes with an internal gear forming part of casting e. This casting and the cone pulley are both loose upon the shaft, but plate c is keyed to it. When lock-pin d engages a notch in plate c, the gears are locked together and the shaft is driven directly by the cone, the entire mechanism revolving as a unit. When lock-pin d is engaged with a stationary arm g, the internal gear is prevented from rotating and motion is transmitted to the spindle of the machine from the cone pulley, as pinion a causes pinion b to revolve about the stationary internal gear and carry with it plate c, which transmits a slower speed to the spindle than

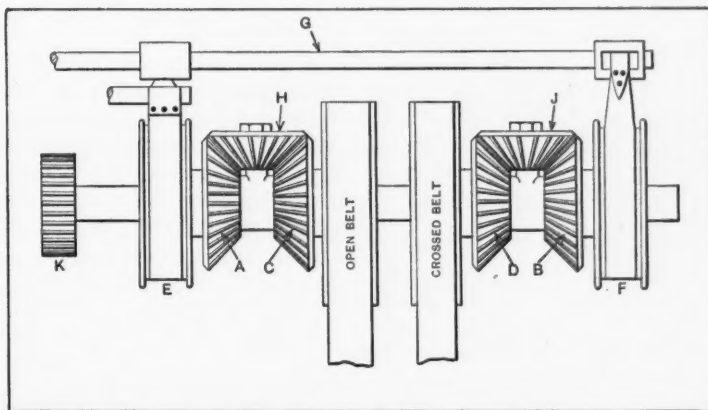


Fig. 6. Differential Governing Mechanism controlled by Ratchet-operated Brakes

has been applied to various classes of machinery. When used in conjunction with a cone pulley, the arrangement is as follows: The cone pulley is loosely mounted on its shaft and carries a pinion a which meshes with gear b. This gear is locked to pinion c, thus forming a double gear that is free to turn about arm d, the hub of which is also loosely mounted on the spindle or shaft. Gear b meshes with gear f, whereas pinion c meshes with gear e. Diametrically opposite arm d, there is another arm which carries gears corresponding to b and c. This additional gearing is included because of its balancing effect and need not be considered in studying the action of the gearing. Gear e is keyed to the spindle, and, except when a direct drive is employed, gear f is stationary. With fulcrum gear f stationary and gear a revolving, gear e and the spindle are rotated at a much slower speed, as arm d and the intermediate connecting gears roll around gear f. The direction in which gear e rotates for a given movement of gear a depends upon the ratio of the gearing, and the direction may be reversed by changing the relative sizes of the

gears. When the ratio $\frac{f \times c}{b \times e}$ is less than 1, gears a and e

will revolve in the same direction, whereas, if this ratio is greater than 1, they will revolve in opposite directions. This is a very compact form of gearing and the velocity ratio may be varied considerably by a slight change in the relative sizes of the gears.

The velocity ratio when $\frac{f \times c}{b \times e}$ is less than 1 may be de-

termined by the following formula, in which the letters represent the numbers of teeth in the gears marked with corresponding reference letters in the illustration:

$$\text{Ratio} = \frac{\frac{f}{a} + 1}{1 - \frac{f \times c}{b \times e}}$$

If gear a has 12 teeth, b, 40 teeth, c, 16 teeth, e, 34 teeth, and f, 46 teeth, then:

$$\begin{aligned} \text{Ratio} &= \frac{46/12 + 1}{1 - \frac{46 \times 16}{40 \times 34}} \\ &= \frac{4 \frac{5}{6}}{39/85} = 10.53 + \end{aligned}$$

Therefore, gear a will revolve 10.53 times while gear e is making one revolution. If the expression

$\frac{f \times c}{b \times e}$ is greater than 1,

the formula may be changed as follows:

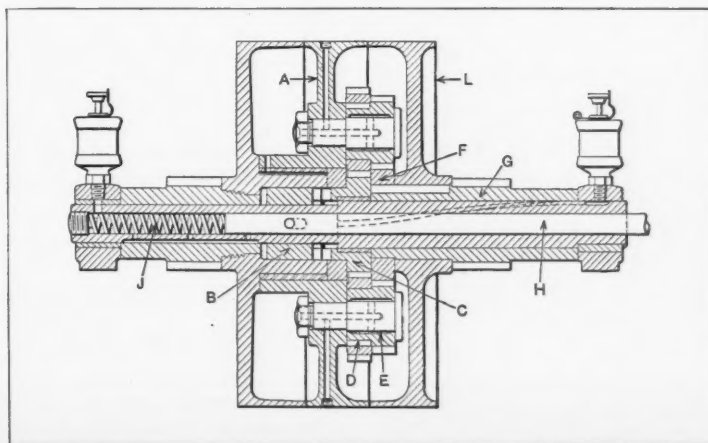


Fig. 7. Compound or Reverted Train of Planetary Gearing for reducing Speed

$$\text{Ratio} = \frac{\frac{f}{a} + 1}{\frac{f \times c}{b \times e} - 1}$$

Differential Gearing of Automobiles

One of the important applications of planetary or differential gearing, at the present time, is found in automobiles. The object of transmitting motion from the engine to the rear axle through differential gearing is to give an equal tractive force to each of the two wheels and, at the same time, permit either

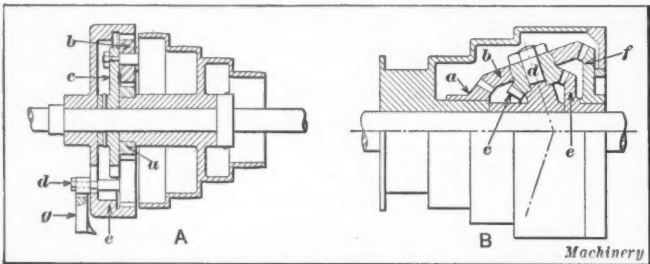


Fig. 8. Planetary Gear and Cone Pulley Combinations for varying Speed

of them to run ahead or lag behind the other, as may be required in rounding curves or riding over obstructions. The axle is not formed of one solid piece, but motion is transmitted to the right- and left-hand wheels by means of separate sections, the inner ends of which are attached to different members of the differential mechanism. The type shown in Fig. 9, which is equipped with bevel gearing throughout, is very generally used, although some "differentials" have spur gears instead of the bevel form. The propeller shaft extends from the transmission case where speed changes are obtained, and revolves the bevel pinion *N* which drives the large bevel gear *M*. This gear *M* and the casing *O* to which it is bolted revolve freely on the hub of gears *F* and *E*. Attached to the casing *O* are radial pinions on which bevel pinions *D* revolve loosely. These pinions engage bevel gears *E* and *F* which are connected with the right- and left-hand axles or shafts *T*. Under ordinary conditions, the rotation of gear *M* causes gears *F* and *E* both to revolve at the same rate of speed, since the connecting pinions *D* are moved around with the casing *O*, but do not revolve. To illustrate the action, assume that the wheels are jacked up and are simply revolving in one position; then, if one wheel is held from turning so that, say, gear *E* is sta-

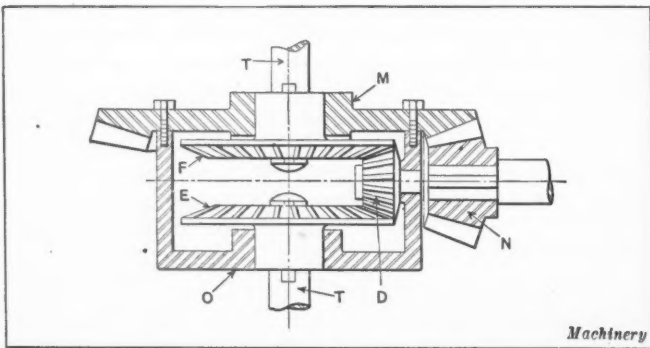


Fig. 9. Common Type of Automobile Differential Gearing

tionary, the rotation of bevel gear *M* will roll pinions *D* around on gear *E*, with the result that gear *F* will revolve twice as fast as when gear *E* is revolving with it and at the same speed. On the other hand, if the opposite wheel and gear *F* were held stationary, the gear *E* would run at twice its normal speed; moreover, if the speed of either of the gears is reduced, the other side is speeded up a corresponding amount.

Where the western division of the East-West Transcontinental Railway of Australia crosses the Nullabor Plain there is a section of 330 miles of absolute straight line, which is the longest length of straight line on any railway in the world.

ROLLER CHAIN STANDARDIZATION

A joint meeting of the roller chain committee of the American Society of Mechanical Engineers and the roller chain division of the Society of Automotive Engineers' standards committee was held in connection with the annual convention of the American Society of Mechanical Engineers in New York last December. It was recommended that roller chain be standardized as follows:

The pitches are to be the existing series of roller chain pitches— $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, and 2 inches, with the addition of a $2\frac{1}{2}$ -inch pitch.

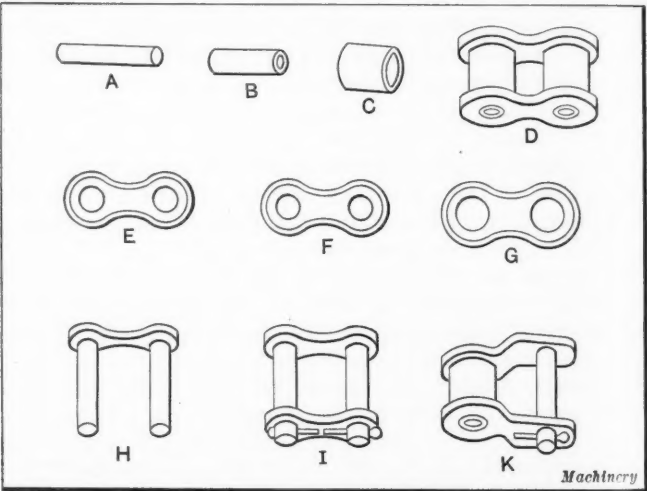
A series of roller diameters was recommended as follows:

Pitch	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{2}$
Roller diameter..	0.306	0.400	15/32	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	1 9/16

The width of chains, defined as the distance between the inside links, was recommended as follows:

Pitch	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{2}$
Width	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	1	1	$1\frac{1}{4}$	$1\frac{1}{2}$

The serious results from the use of sprockets with over-size "bottom diameters," and chains with under-size "lengths" were emphasized. It was also recommended that the trade numbers of roller chains giving the recommended pitches be prefixed by the word "Universal." The number of the chain is equal to the number of quarter-inches in the pitch; thus,



Nomenclature of Roller Chain Parts

for example, a chain of $\frac{1}{2}$ -inch pitch will be known as "Universal No. 2 roller chain."

The nomenclature indicated by the accompanying illustration was recommended for the component parts of a roller chain: A, pin; B, bushing; C, roller; D, roller link; E, pin link plate; F, connecting link plate; G, inside plate; H, pin link; I, connecting link; K, offset link.

ECONOMY IN USE OF LUBRICATING OILS

Notices are displayed in German machine shops giving hints on economy in lubricants which should be valuable in any country. These are:

Use only closed oil-cans with spouts that will deliver drops or at most only a thin stream.

Use all lubricating apparatus strictly according to the instructions and put the oil only where it will actually lubricate. If a machine has automatic droppers, shut off the supply while the machine is standing.

Do not use cylinder oil on shafting or elsewhere when cheaper oil will answer.

Keep all rubbing surfaces in good condition; rough surfaces and too tight boxes consume more oil; worn and leaky bearings waste oil.

Always use drip pans and arrange to filter and cleanse the oil so caught; it is as good as new.

Collect all greasy waste and wiping cloths, so that the oil may be recovered; never burn them.

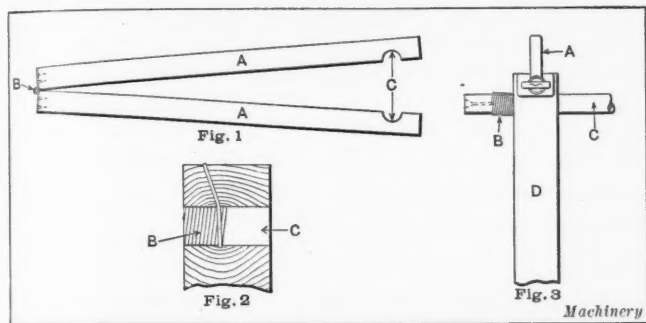
Be careful about using lubricating oil for cooling a bearing; water will often do as well.

Be careful about using oil for cleaning and polishing. Never clean the hands with oil; a greasy cloth will do as well.—Commerce Reports

DEVICE FOR WINDING SPRINGS

BY GUSTAVE J. HORAK¹

No doubt everyone, at one time or another, has experienced trouble in making helical expansion and compression springs. While most springs may be made by clamping the wire between two pieces of brass and the tool-holder and setting the lathe so as to feed a certain number of revolutions per inch, phosphor-bronze or brass wire often gives trouble because the tension is not strong enough or is irregular. It is well known that, although phosphor-bronze wire is not as hard as piano wire, it does not hold its shape after being bent as well as the latter. Springs made of fine wire but of large diameter generally give trouble. When they are taken off the mandrel, light can be seen between the coils, and the springs are very weak, because the larger the diameter of the spring the smaller is the angle at which the wire bends, and consequently, as there is no tension, there is no contracting energy in the spring. It is necessary, in such a case, to find some means of



Figs. 1 to 3. Method of winding Brass or Phosphor-bronze Springs

pressing the coils against one another as the spring is forming, in order that there may be no air space between the coils when the spring is finished.

To accomplish this result, the writer uses two pieces of hard wood, which are hinged and grooved as shown in Fig. 1. Hard wood is absolutely necessary, as the harder the wood is the longer it will hold the thread that is cut into it. The strips A of wood should be about eight or nine inches long, an inch wide, and a half inch thick; the length depends on the diameter of the spring. The strips are fastened together at one end by a hinge B, and a groove C is cut near the other end. This groove must fit the mandrel on which the spring is to be wound, but it must not be so deep that it will entirely enclose the mandrel; the ends of the sticks should be separated about three-sixteenths inch when the strips of wood are clamped over the mandrel.

Drill rod should be used for the mandrel because its surface is hard and smooth and it is not readily cut by the pressure on the spring; but if only a small number of springs are to be made, Bessemer rod will do. The objection to using a soft rod is that after a number of springs are wound, the surface of the mandrel becomes cut and grooved so that the spring becomes uneven. One end of the mandrel should run on a center while the other end is held in a chuck so that the rod will run true. A small hole should be drilled through the rod near the chuck end so that the wire can be passed through it and fastened by being bent over on the other side.

Now as the wire is held tightly with one hand the machine should be turned over with the other and six or seven coils formed on the mandrel; then form two coils on top of the coils already formed, winding the wire back at such an angle that about one-half revolution will bring it on top of and between the second and third coils of the spring. Great care must be taken to hold the wire very tightly, so that when it is wound on top of the other coils, it will not slip down between the coils. When the wire is wound on top properly, it should appear as is shown in Fig. 2, where B represents the coils of the spring, and C the groove in the block.

The blocks should then be placed over the mandrel so that the grooves will fit over the spring snugly and a hand vise or clamp fastened over them just tight enough to hold the wire in place. As the machine is again turned by hand, the wire

should cut into the wood, reproducing the shape and coils of the spring. The section of wire that is laid back must rest on top of the wire and not down between the coils. This is easily done by holding the wire very tightly until the clamp is in place. When the spring has once cut a thread in the wood, this part of the wire should cut a deep groove in the wood running diagonally back across the rest. The impression in the wood should be as shown in Fig. 2.

The point where the wire begins to turn back must always be embedded in the wood; it must never come in the space between the strips of wood. When the impression is once made in the wood, the same grooves can be used many times by taking care to see that the wire is always in the same grooves at the beginning as in the case of the last spring cut. When a few turns have been made, after clamping the strips together and making sure that no space can be seen between the coils, the clamp should be tightened still more. If a space appears between the last two turns and the rest of the spring, the overlapped wire has sunk down, showing that the wire was held too loose at the beginning. The remedy is to take off the clamp and start over again, taking care to hold the wire very tightly.

It is better to tighten the clamp a little at a time, making a few turns between each tightening, because then a thread is cut in the wood gradually and the overlaid wire is not forced down, as it will be if the clamp is tightened too much at once. This precaution is necessary only when a new groove is being started; after a groove is once formed, the clamp may be tightened sufficiently at once. If no space can be seen between the coils when the clamp is tightened the second time, the blocks should be held in one hand and the power started. As the spring forms, it will force the blocks toward the end of the rod, and all that is then necessary is to feed the wire fast enough. It does not have to be held tight, as there will be sufficient tension between the blocks.

This method eliminates all the trouble of setting up a lathe to a certain feed per inch to correspond with the number of turns in the spring, which was always necessary by the old method; and it sometimes happened that the right feed could not be obtained. As high a spindle speed can be used as can be obtained without overheating the wire. The spring will become heated considerably, but this does no harm unless the wire begins to color; in this case a little lard oil should be applied to the mandrel; never on the spring. However, oil should be used only when absolutely necessary, as the slight heating increases the strength of the spring. This is especially true of phosphor-bronze and spring brass wire, which will stand considerable heat without annealing.

Sometimes the temper of wire varies; some wire will be found harder and more brittle than another section off the same spool. In such cases it will be necessary to vary the tension on the wire. The harder the wire, the less it will have to be laid back, and *vice versa*. Different tensions are easily obtained by laying the wire back more or less. Experimenting with different kinds of wire will soon show the exact tension required. If after the spring is taken off the mandrel it forms a series of loops when expanded, the wire was laid back too far. If the spring has no strength, the tension was not sufficient. For average wire, two turns back will be found about right. The method of clamping blocks over the wire is shown in Fig. 3, where A is the clamp, B the wire, C the mandrel, and D the wooden blocks. The wire should run up through the blocks from the back of the lathe. Wire up to one-eighth inch in diameter can readily be wound by using longer clamps and blocks.

Helical compression springs can also be made by this method. In this case a hook should be made out of a piece of wire, the exact diameter of the space between the coils of the spring that is to be made, and passed over the rod between two coils of the wire. The wooden strips should be clamped over the mandrel as before and the threads cut. When this is done the wire hook can be removed.

It will be found that with this device one man can make three or four times as many springs as was possible before, and they will be more uniform. Although used in many cases, this method has never failed to produce good results.

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GRAPHIC METHOD OF GENERATING AN INVOLUTE GEAR TOOTH

EASY METHOD OF LAYING OUT GEAR TEETH ABOVE AND BELOW BASE CIRCLE

BY DOUGLAS T. HAMILTON¹

AN involute curve is one that may be described by the end of a cord as it is unwound from a circle. In practical gear-tooth design, however, the string is replaced by more exact methods of generation, which, however, are just as simple in principle and are easily mastered by any draftsman or mechanic. The method described here is a practical and correct way of generating an involute gear tooth like that produced by the gear shaper.

The first thing necessary is to decide on the scale to which the drawing is to be made. If an analysis of the tooth action merely is desired, an enlargement of 4 to 1 is satisfactory.

If, on the other hand, it is desired to find the strength of a gear tooth, a 10 to 1 scale is preferable. The next step is to draw a vertical line representing the axis of the gear tooth, as shown in Fig. 1, then lay off on this line the various elements of the tooth, such as the addendum and the pitch radius. Now, placing the needle point of a pair of compasses (or trammels) on the center of the gear, describe the pitch and addendum circles, and the base circle, from which the involute curve of the tooth is generated. The position of the base circle can be determined by means of a protractor, or it can be calculated. To find the base circle diameter by calculation, multiply the cosine of the pressure angle by the pitch diameter. If a drafting machine is available, set it at $14\frac{1}{2}$ degrees or 20 degrees, depending on the pressure angle of the gear to be investigated; then move it until the horizontal scale is on the point where the pitch circle cuts the vertical center line (this is known as the pitch point), and draw the angular line that represents the pressure angle or line of action. Then describe a circle that is tangent to and cuts this line, as illustrated in Fig. 1. With a pair of dividers, lay off the distance indicating the thickness of the tooth on the pitch line.

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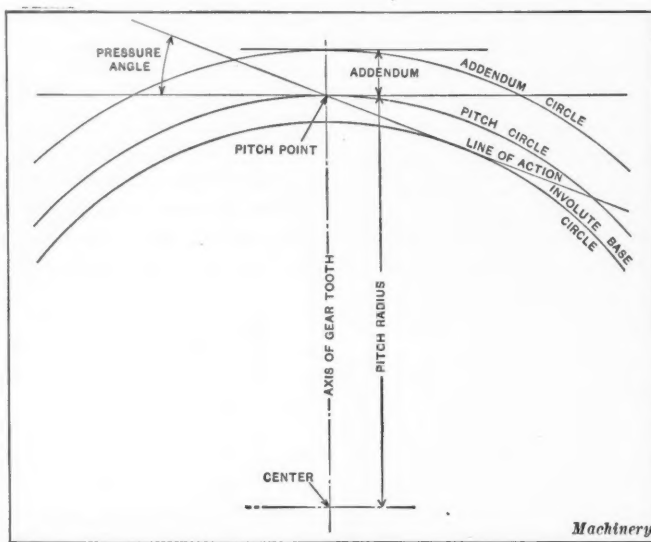


Fig. 1. Laying out Tooth Elements on Tooth Axis

Generating the Involute Curve

The involute curve for a gear tooth can be very accurately laid out on the drafting board if proper care is taken. After the base circle diameter is laid out, with a pair of dividers, space off on it an equal number of divisions. The number of divisions is unimportant, but the smaller the divisions the more accurate will be the curve that is constructed. As a general rule, the divisions should be such that the arc between the axis of the tooth and the point of tangency of the line of action with the base circle diameter should be divided into five equal parts.

After dividing the base circle, as shown in Fig. 2, draw lines tangent to the base circle, starting from the various points of division on the circle. If a drafting machine is not available, this can be accomplished by drawing lines from the division points on the base circle to the center of the gear and then using a regular triangle for laying off the tangent lines. If a drafting machine is available and has a scale long enough to reach from the base circle radius to the center, these radial lines are not necessary. If, on the other hand, the scale on the drafting instrument is not long enough, the radial lines should be drawn and one scale of the drafting instrument should be set parallel with these radial lines and the drafting instrument moved up, as shown in Fig. 3; lines tangent to the base circle may then be drawn from the points of tangency. This procedure is continued until enough divisions have been made for the involute curve of the tooth to be laid off accurately.

When the tangents, as indicated in Figs. 2 and 3, are drawn, the involute curve of the tooth above the base circle may be laid off. Set the needle point of a pair of compasses on the division point A of the base circle, Fig. 4; this is the starting point on the tangent line nearest to the point on the pitch

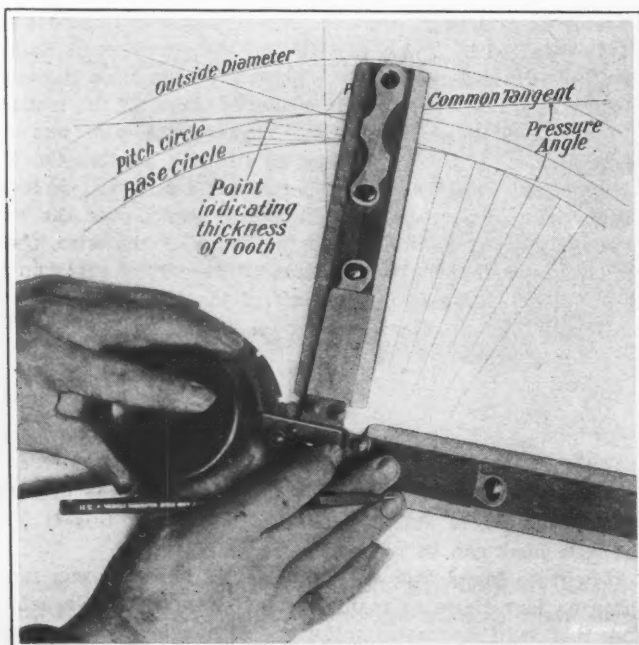


Fig. 2. Second Stage, showing Divisions laid out on Base Circle

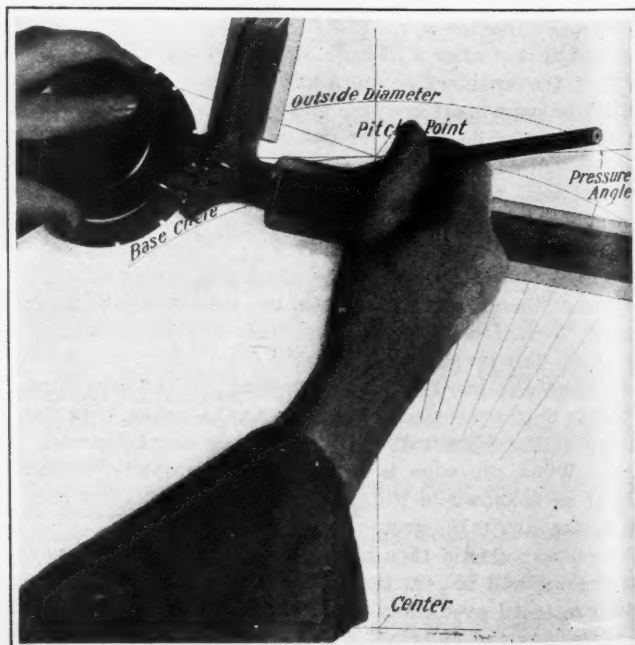


Fig. 3. Using Drafting Instrument when Scale is too Small

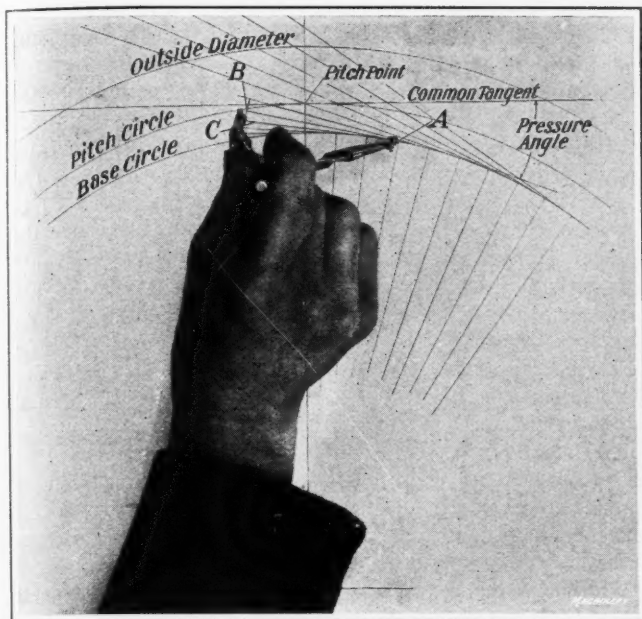


Fig. 4. Laying off Curve above Base Circle

circle and indicates the thickness of the tooth. Then describe an arc cutting the point on the pitch circle representing the thickness of the tooth and covering the distance included between the two tangent lines B and C. This process is repeated with the other points of division on the base circle as center points and describing arcs cutting the tangent lines, until the involute curve is complete. Care must be taken in all cases to see that the arcs accurately join each other; otherwise the involute curve will not be accurate. When the curve above the pitch line is complete, the flank and fillet, or that part of the tooth below the base circle, may be generated.

Constructing Diagram for Gear Shaper Cutter Tooth

Before the fillet can be laid out, it is necessary to make a diagram of the gear shaper cutter tooth on tracing cloth. This is constructed in exactly the same way as the gear tooth just described, with the exception that the addendum is made 25 per cent greater than that of the gear tooth. Also, the pitch diameter of the cutter should be made 3 inches for gears of 7 pitch and finer, and 4 inches for gears of 6 pitch and coarser. The scale to which this diagram is drawn should be the same as that used for the gear tooth. The form of the diagram for the gear shaper cutter tooth is shown in Fig. 5.

Generating the Flank and Fillet

The flank and fillet of the gear tooth are generated in a different manner from that used in constructing the involute

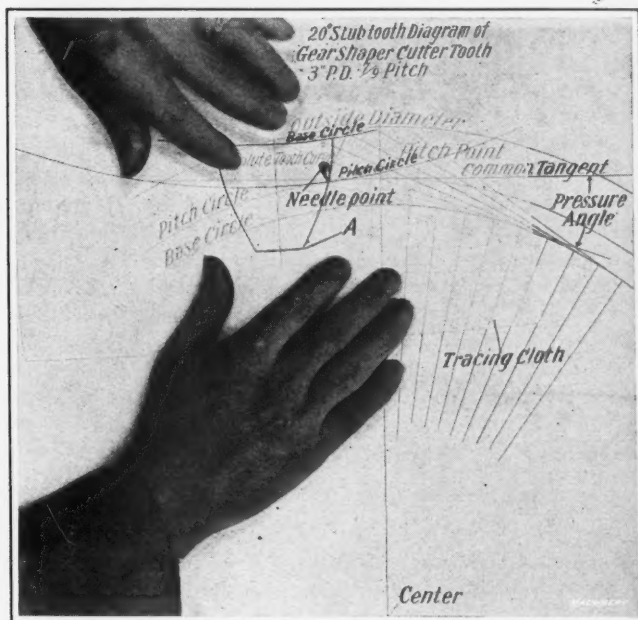


Fig. 5. Diagram of Gear Shaper Cutter Tooth

curve above the base circle. The procedure, however, is simple if the proper precautions are taken. It consists simply in rolling the cutter tooth diagram on the diagram of the gear tooth, care being taken to keep the pitch circles of the two diagrams tangent to each other. Place the diagram, as indicated in Fig. 5, with the two pitch circles and the two involute curves tangent to each other; then, by means of a needle point, prick through the tracing cloth into the drawing, holding the cutter diagram in the position indicated. The cutter tooth diagram is now located on the starting point from which the flank and fillet are generated. To proceed, hold the cutter diagram in place so that it does not slip, and move the needle point from the point of tangency of the involute curve to the place where the two pitch circles start to separate, moving it slightly to the left of the position shown in Fig. 5. With the needle point in this position, swing the tooth diagram toward the gear tooth, and with another needle point prick through the extreme inward point A of the cutter tooth. Continue this process until the tooth diagram is rolled around sufficiently on the pitch circle of the gear for the point of the tooth to pass the involute base circle diameter, thus completing the flank and fillet of the gear tooth. If the gear has a small number of teeth and the pressure angle is $14\frac{1}{2}$ degrees, the point of the tooth will not come exactly in line with the involute curve at the base circle, but will fall inside the curve, indicating that there is a certain amount of under-cutting of the tooth.

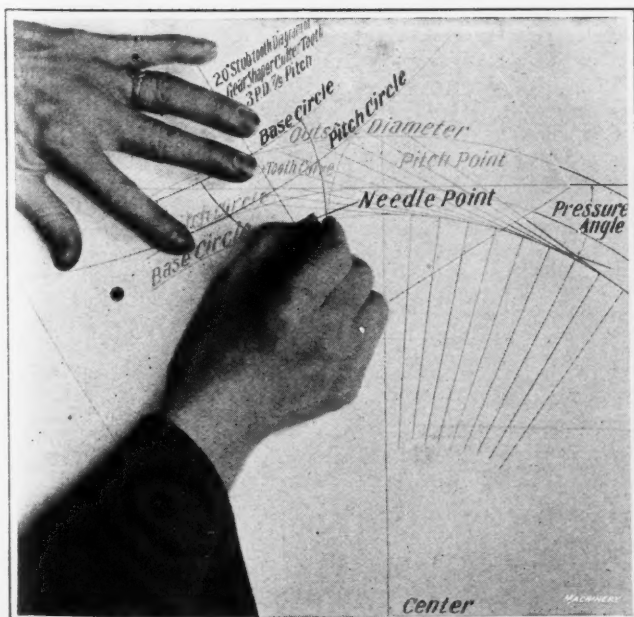


Fig. 6. Last Step in laying out Flank and Fillet of a Gear Tooth

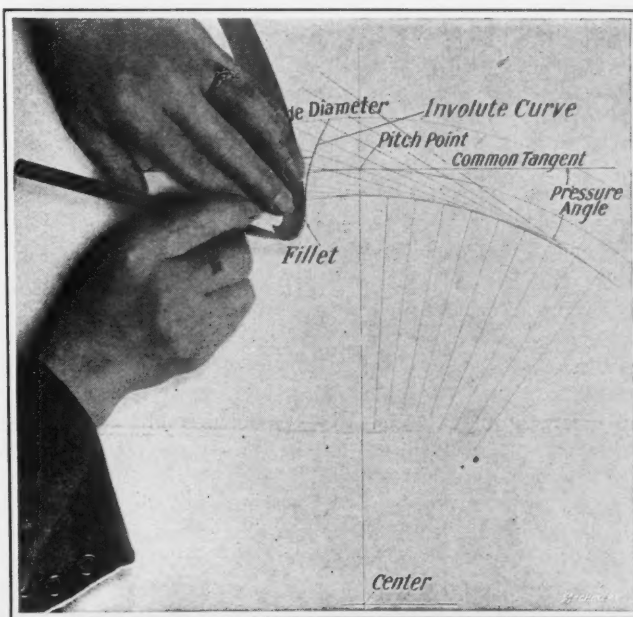


Fig. 7. Completing Flank and Fillet

The only precaution that need be taken in generating an accurate flank and fillet is to draw the tooth diagram accurately, having fine inked lines for the pitch circles and involute tooth curves and using a very fine needle point so that the various points indicating the sweep of the cutter tooth will be accurately located. It is also necessary to keep the cutter tooth diagram from slipping on the drawing and to keep the two pitch circles tangent to each other, or the curve generated will not be accurate. If proper care is taken, however, a very accurate flank and fillet can be generated.

Fig. 6 shows the gear shaper cutter tooth diagram swung around to the point where the point of the cutter tooth has practically reached the base circle diameter. A comparison of this illustration with Fig. 5 will give a clear idea as to how the generation of the flank and fillet is accomplished. After the cutter tooth diagram is swung around to the point indicated in Fig. 6, the construction of the flank and fillet is completed. The only step remaining to complete one side of the gear tooth is to connect the various needle points on the drawing by means of an irregular curve, as indicated in Fig. 7. The other side is generated in a similar manner.

Generating the flank and fillet of a gear tooth produced by a hob is accomplished by using a diagram that, instead of having the outline of the gear shaper cutter tooth drawn on it, has the outline of a rack tooth. The method of generating the lower part of the tooth is the same as that just described, with the one exception that for small numbers of teeth the hob tooth should be corrected for interference, this being automatically taken care of in the gear shaper cutter.

* * *

PROPOSED NEW BRITISH PATENT LAW

The president of the Board of Trade of Great Britain has introduced into the House of Commons a bill to amend the Patents and Designs Act of 1907. The main purposes of the amended bill are stated to be the prevention of abuses of the monopoly rights under patents, and the securing of new inventions that shall, if possible, be worked on a commercial scale in the United Kingdom without undue delay.

The section in the 1907 act which dealt with compulsory working has been cancelled and in its place there is a new section, according to which any person may, at any time, present a petition to the comptroller alleging that there has been abuse of the monopoly rights under the patent, and asking for relief. Monopoly rights under a patent are deemed to be abused if, after the expiration of four years from the date of the patent, a patented invention (being one capable of being worked in the United Kingdom) is not being worked within the United Kingdom on a commercial scale, and no satisfactory reason is given for such non-working. It will also be an abuse of the monopoly rights of a patent if the working of the invention on a commercial scale is prevented or hindered by the importation from abroad of the patented article, either by the patentee or by infringers against whom the patentee has not brought action. It will also be regarded as an abuse of the monopoly rights of a patent if the demand for the patented article is not met to an adequate extent and on reasonable terms; or if the patentee refuses to grant licenses upon reasonable terms; or if any trade or industry is unfairly prejudiced by the conditions attached by the patentee, to the purchase, hire, or use of the patented article, or to the using or working of the patented process. The petition is heard by the comptroller, and if he is satisfied that the allegations are true, he has several alternative modes of dealing with the matter. For instance, the comptroller may grant the petitioner an exclusive or a non-exclusive license, or he may order the patent to be revoked. If the comptroller grants an exclusive license to a petitioner, the patentee is to be precluded from himself working or using the invention, but is to be protected in that he is to secure the maximum royalty compatible with the licensee working the invention on a commercial scale and at a reasonable profit, and he is also to be guaranteed a minimum yearly royalty, the license to be revocable if the licensee fails to carry out the terms of the license. The new proposal appears to be much better and fairer both to the patentee and to the public than are the terms of the present law.

The term of a British patent is fourteen years. There have been constant demands that the term should be lengthened, and it is now proposed that British patents shall be granted for a term of fifteen years, thus bringing British practice into line with that of many foreign countries.

The proposed patent law also provides that if one or more claims in a patent specification are valid, the court, in an action for infringement, may grant relief in respect to the infringed claims without affecting the validity of any other claims in the specification. Hence a patent will not be invalid, as is now the case, if one single claim happens to be invalid, but as much of the patent as is found valid will be upheld and remain in force.

Patents of addition are also covered by the proposed law. At the present time a patent of addition expires with the main patent. This sometimes appears unjust, as the patent of addition may protect valuable new inventions. The amended law provides that if the main patent expires, the patent of addition shall, if a court or the comptroller so orders, become an independent patent, subject to renewal fees and with a life equal to the unexpired portion of the patent.

A bill has also been introduced to amend the Trademark's Act of 1905. This bill, if passed, will effect material changes in the uses of American trademarks in Great Britain, and in some instances will involve the practical confiscation of trademarks and the good will obtained through them. This bill provides that if the proprietor of a word-trademark registered after the passing of the bill, by advertisement or otherwise, causes the general public to make use of the word so registered as the name or general description of an article or type of article, and not as denoting an article or type of article specifically made by the manufacturer himself, the trademark shall be removed by the court from the register of trademarks.

It further provides that at any time after the expiration of four years from the passing of the bill, any word-trademark registered before the passing of the bill which is generally used by the public as the name or general description of any article, may upon the application of any person aggrieved be removed by the court from the register. It is apparent that there are a number of trademarks that have gradually come to refer to articles of a general class, irrespective of who is the manufacturer, and such trademarks would be invalid under this act.

* * *

STANDARD SYMBOLS

The Committee on Technical Nomenclature of the Society for the Promotion of Engineering Education, consisting of John T. Faig, S. C. Earle, W. D. Ennis, F. N. Raymond and Charles Warren Hunt, has prepared the accompanying tentative list of symbols to be used in works on mechanics. This list was prepared through consultation, by means of correspondence, with a large number of professors, editors and engineers in the mechanical field.

A = area;	M = moment of force or sum of moments of forces;
a = linear acceleration;	m = mass;
b = breadth;	N = revolutions per unit of time;
C = constant;	O = center of rotation;
c = distance of extreme fiber from neutral axis;	P = concentrated load;
D = diameter;	Q = quantity of liquid flowing, in pounds;
d = depth;	R = reaction;
E = Young's modulus of elasticity;	R_h = hydraulic radius;
e = eccentricity of application of load;	r = radius;
e_h = hydraulic efficiency;	S_t = unit stress in tension;
e_m = mechanical efficiency;	S_c = unit stress in compression;
e_v = volumetric efficiency;	S_s = unit stress in shear;
F = force;	s = distance passed over;
f = coefficient of friction;	T = torque;
g = acceleration due to gravity;	t = time;
H = head;	V = volume;
H_p = horsepower;	v = linear velocity;
h = height;	W = weight of a body, or total weight;
I = rectangular moment of inertia;	w = angular velocity;
K = coefficient; constant;	y = deflection of beam;
k = radius of gyration;	Z = modulus of section.
L = length;	

COMPARISON OF COMPENSATION ACTS

PRINCIPLES ON WHICH COMPENSATION ACTS ARE BASED AND COMPENSATION ALLOWED IN EACH STATE

BY OHESLA C. SHERLOCK¹

ONE does not get a comprehensive view of the workmen's compensation acts unless a thorough study is made of the compensation laws enacted by each state of the union. An individual statute may be taken as a model and held up for purposes of illustration, but to really know the law of any one state, that law must be compared with the laws of other states. The compensation acts of the different states are modeled quite generally after the English act of 1906. The later American laws had the benefit of the experience of sister states, with the result that some of these laws are, in the words of the Iowa industrial commissioner, "the product of the shears rather than of the pen." Because of this use of the shears, many flaws have crept in which have quite seriously discriminated against the rights of workmen and have unconsciously operated to the gain of the employers.

Compensation is based upon the principle that it is fundamental justice that if a man is injured while engaged in the production of wealth for society, society should share the loss. This principle is so well grounded in common sense and fair play that it became strong enough to overturn the ancient common-law rules for the treatment of injuries and the adjustment of the rights of master and servant. No more revolutionary or drastic legislation was ever enacted, and at the same time was so universally upheld by the courts. Such legislation, from a legal standpoint, would have been impossible a half century ago. It was modern industrialism that paved the way, and it was the increasing interest of the world in this game of industrial achievement that eased the minds of the masses and created the popular demand so necessary to a reform movement.

While there is some difference in the industrial situation of the different states, there seems to be no valid reason for so great a difference in the actual working out of the respective statutes. The principle underlying the compensation laws is the same everywhere. Because of constitutional objections, the acts are largely optional; that is, an employer may come under the provisions of the law at his pleasure or he may reject the terms of the law and run the risk of common-law action for damages. The acts have, however, attempted to save the employer from common-law liability where he has elected to accept the law, and have taken from the workman the right to bring suit at all. In cases where the employer

TABLE 1. SCHEDULE OF RATES PROVIDED BY WORKMEN'S COMPENSATION ACTS

State	Per Cent of Weekly Wage	State	Per Cent of Weekly Wage
Massachusetts	66 2/3	Minnesota	50
New York	66 2/3	Montana	50
Ohio	66 2/3	Nebraska	50
California	65	Nevada	50
Wisconsin	65	New Hampshire	50
Kentucky	65	New Jersey	50
Texas	60	Oklahoma	50
Indiana	55	Pennsylvania	50
Ontario	55	Rhode Island	50
Arizona	50	Vermont	50
Colorado	50	West Virginia	50
Connecticut	50	Oregon, \$30 to \$50 per month maximum	60
Illinois	50	Washington, \$15 to \$35 per month maximum	60
Iowa	50	Wyoming, \$15 to \$35 per month	60
Louisiana	50	Kansas	25 to 50
Maine	50		
Maryland	50		
Michigan	50		

elects to reject the law, the acts have taken from him his old common-law defenses of contributory negligence, assumption of risk, and the so-called fellow-servant doctrine. The effect of this action is that the employer's hands are virtually tied

so that he has no means of defending himself in a common-law suit for damages. The tendency has been to make the way of the employe easy and that of the employer hard.

There can be no doubt of the wisdom of the attempt to take disputes between employers and employes out of the courts. Litigation under the old order was not very fruitful of results for the injured workman, and in the few cases where recovery was had they were generally grossly unjust to the employer. One man might win \$30,000 for the loss of a leg, while dozens

TABLE 2. LENGTH OF PERIOD BEFORE COMPENSATION BEGINS

Weeks		Weeks	
Arizona	2	Nevada	2
California	2	New Hampshire	2
Colorado	3	New Jersey	2
Connecticut	10 days	New York	2
Illinois	1	Ohio	1
Indiana	2	Oklahoma	2
Iowa ¹	2	Ontario	1
Kansas	2	Oregon	None
Louisiana	1	Pennsylvania	2
Maine	2	Rhode Island	2
Maryland	2	Texas	1
Massachusetts	10 days	Vermont	2
Michigan	2	Washington	None
Minnesota	1	West Virginia	1
Montana	2	Wisconsin	1
Nebraska	2	Wyoming	10 days

¹ Absorbed in fifth, sixth and seventh weeks of incapacity

of others became public charges and died in almshouses. The common-law theory of damages was based upon the theory of fault. Locate the fault for the injury and the law would then assess damages against the offending party. But our complex industrial system was fast making a farce of this old and tried legal principle. Justice Brandeis, in his dissenting opinion in the case of the New York Central Railroad Co. *versus* Winfield, very ably states the matter in the following words:

In the effort to remove abuses, a study had been made of facts, and of the world's experience in dealing with industrial accidents. That study uncovered as fiction many an assumption upon which American judges and lawyers had rested comfortably. The conviction became widespread that our individualistic conception of rights and liability no longer furnished an adequate basis for dealing with accidents in industry. It was seen that no system of indemnity dependent upon fault on the employer's part could meet the situation, even if the law were perfected and its administration made exemplary. For, in probably a majority of cases of injury, there was no assignable fault; and in many more it must be impossible of proof. It was urged: Attention should be directed, not to the employer's fault, but to the employee's misfortune. Compensation should be general, not sporadic; certain, not conjectural; speedy, not delayed; definite as to amount and as to time of payment; and so distributed over long periods as to insure actual protection against lost or lessened earning capacity.

While these statements are equally applicable to all the states, a vast difference in their statutes exists. It is worth 16 2/3 per cent more per week of his average wage for a workman to be injured in Massachusetts than in Iowa. A workman in Indiana receives 55 per cent of his average weekly wages, while across the Ohio River in Kentucky he would receive 10 per cent more. A workman injured in Michigan would receive 50 per cent of his average weekly wage, while if he were hurt in Wisconsin, he would receive 15 per cent more, or 65 per cent. Table 1 shows the percentage of his weekly wage recovered by a workman for all injuries suffered by accident arising out of and in the course of the employment. For instance, if a workman earns twelve dollars a week, his weekly payment in Illinois will be six dollars, while in New York it will be eight dollars.

¹Address: Box 253, Des Moines, Iowa

Length of Period before Compensation Begins

Compensation does not, however, start as soon as a workman is injured, or even from the date of incapacity. The acts have quite generally provided a "waiting period" for the employer's protection against workmen who would rather feign than work. As a result, compensation does not commence to run until a certain date after the date of incapacity. The waiting period does not date from the time of injury unless the incapacity started at the same time. This distinction between the date of injury and the date of incapacity should be kept in mind, for a man may be injured long before he is incapacitated so that he cannot do his usual work. Take, for instance, a man who receives a scratch on his hand. He

TABLE 3. MEDICAL AID PROVIDED BY WORKMEN'S COMPENSATION ACTS

State	Length of Period	State	Length of Period
Arizona	None	Nevada	4 months
California	90 days	New Hampshire...	None
Colorado (\$100)...	30 days	New Jersey (\$50).	2 weeks
Connecticut	30 days	New York.....	60 days
Illinois (\$200)....	8 weeks	Ohio (\$200).....	
Indiana	30 days	Oklahoma	15 days
Iowa (\$100).....	4 weeks	Ontario	None
Kansas	None	Oregon (\$250)....	
Louisiana (\$150)..	2 weeks	Pennsylvania (\$75)	
Maine (\$30).....	2 weeks	Rhode Island.....	2 weeks
Maryland (\$150)..		Texas	2 weeks
Massachusetts—no		Vermont (\$75)....	1 week
limit		Washington	2 weeks
Michigan	3 weeks	W. Virginia (\$150)	None
Minnesota (\$200)..	90 days	Wisconsin	90 days
Montana (\$50)....	2 weeks	Wyoming	None
Nebraska (\$200)...	21 days		

Machinery

may be apparently well for two or three weeks, when blood poisoning will set in and incapacity result.

It is a rule that not more than one waiting period can be deducted from the amount of time lost by a workman. In many instances, workmen will be incapacitated one week after the waiting period, will return to work for a day or two, suffer a relapse for a week or so, and return to work again. Oftentimes a workman will make several attempts to return to work when he is not in physical condition to do so.

Table 2 shows the waiting periods in the various jurisdictions in America. The Iowa statute is unique in respect to this provision. While it follows the beaten path and provides for a waiting period of two weeks during incapacity from earning full wages, it reimburses the workman in case his incapacity extends to the fifth, sixth and seventh weeks by providing that one-third of two weeks' compensation be paid him during those weeks in addition to the regular compensation. In this way all the advantages of a waiting period are secured, and, in aggravated cases, the workman is not deprived of two weeks' compensation.

Workmen are often inclined to feel that the compensation acts were designed to favor the employer and to discriminate against them. Perhaps this feeling is never so noticeable as when they realize that there is a waiting period during which they cannot receive any compensation at all. Workmen who find themselves incapacitated and destitute are well-nigh desperate when they must face a waiting period ranging from ten days to three weeks in length. Those who feel this way, however, have lost sight of the underlying principle of compensation, namely, that the acts do not seek to provide damages or indemnity, but to share the loss of wages through the lessened or lost earning power of the injured man. Perhaps the most fruitful source of disagreement in compensation practice is due to a misunderstanding of the purpose of the acts. The old common-law theories of damage are almost as firmly implanted in the minds of the workmen as they are in the mind of the old-fashioned lawyer. It is hard to persuade these people that the "old order changeth" and to make them see the light. But, under the old system, the workman was in a sorry plight. When he became incapacitated, his income stopped and he had slight hope of reimbursement, even through the aid of the courts. The average waiting period under the acts is two weeks. This means that in the great

majority of jurisdictions the compensation will start to run on the fifteenth day of incapacity and that the workman will receive his first compensation at the end of the third week.

Medical Aid Provided by Employer

In addition to the compensation provided for, the acts also provide that the employer shall furnish reasonable medical, surgical and hospital aid to the workman within certain limits. The extent of time during which this aid is to run varies greatly in the different states. Limitation is usually placed upon the amount to be expended, as shown by Table 3. It will be noted, however, that the aid provided runs, in the majority of cases, through the entire waiting period at least, so that the workman need not be troubled with medical bills or the dread of them during the time that he is not receiving compensation.

The provision for the payment of medical aid is of great advantage to the average workman. It insures competent medical attention at a time when it is greatly in demand. Further than that, it secures this attention at a time when, under ordinary circumstances, no attention would be given at all if the workman were paying the bills himself. The result is that the workman is back at work as soon as the medical profession can remedy his injuries. It means a conservation of our industrial forces and a preservation of life and limb, which was not possible under the old common-law or employer's liability systems of treating these cases.

Then there is another feature which cannot be emphasized too strongly. The acts generally provide that the employer shall have the right to designate what physician the injured workman shall consult during the time that the employer is required to pay the bill. Workmen often make strenuous objection to this provision of law, but if they really understood it they would see that it was to their own advantage. Inexperienced workmen often do not exercise good judgment in selecting their own physicians. Oftentimes they consult quacks, fakirs and other unscrupulous shysters. They are quick to adopt doubtful remedies and are easily imposed upon by the shyster fraternity. In the end they find themselves stripped of the amount of money set aside for medical aid and they do not have competent care. On the other hand, the employer is anxious to provide competent medical attention because he wants the injured man cured and back at work. As long as a workman is incapacitated, he is a burden upon industry; as soon as he returns to work, he will earn more money and will not be a burden to industry.

Amount of Compensation Allowed

The amount of compensation allowed in the various states is limited by the express wording of the statutes. A certain

TABLE 4. MINIMUM AND MAXIMUM WEEKLY PAYMENTS ALLOWED BY WORKMEN'S COMPENSATION ACTS

State		Amount of Payment		State		Amount of Payment	
		Min.	Max.			Min.	Max.
Arizona				New Hampshire			
California	\$4.16	\$20.83		New Jersey....	\$5.00	\$15.00	
Colorado	5.00	8.00		New York.....	5.00	15.00	
Connecticut ...	5.00	10.00		Ohio	5.00	12.00	
Illinois	6.00	12.00		Oklahoma	6.00	10.00	
Indiana	5.50	13.20		Ontario		21.15	
Iowa	6.00	15.00		Oregon ¹		50.00	
Kansas	6.00	15.00		Pennsylvania ..	5.00	10.00	
Louisiana	3.00	10.00		Rhode Island...	4.00	10.00	
Maine	4.00	10.00		Texas	5.00	15.00	
Maryland	5.00	12.00		Vermont	3.00	12.00	
Massachusetts ..	4.00	10.00		Washington ¹ ...		35.00	
Michigan	4.00	10.00		West Virginia..	5.00	10.00	
Minnesota	6.50	11.00		Wisconsin	4.69	9.37	
Montana		10.00			6.25 ²	15.63 ²	
Nebraska	5.00	10.00		Wyoming			
Nevada ¹	20.00	60.00					

Machinery

¹ Per month ² For railway men

minimum and maximum is set and all compensation payments must range between these limits. Speaking broadly, the purpose of the acts is to make a payment to the workman graduated according to his earning power, within certain limitations. In New Jersey, for instance, a workman will receive

50 per cent of his wages, but the compensation must not exceed fifteen dollars a week nor be less than five dollars. In Arizona, New Hampshire and Wyoming there are no minimum or maximum amounts. Some of the states, such as Nevada and Washington, base the limitation upon the amount to be paid per month, while the remainder of the states express the minimum and maximum payments in terms of weekly payments. Table 4 shows the limitation of payments fixed by law.

Future of Compensation Acts

Compensation, while comparatively new in this country, has withstood the most severe shocks of changing industrial conditions. It is about to be put to a new test, namely, the war test—the fiercest and most unrelenting test that can come to any legislation. If it withstands the shock of war, the compensation system will be assured to future generations. While this is of untold importance, it is not nearly so essential as to preserve the system for the benefit of the working classes during the trials that are bound to come in the next three to five years. A tremendous strain is put upon the industries of this country by the war. Every effort is being made to increase production, to speed up every department of human activity, and to make prompt deliveries. All this means that an unusual number of accidents are bound to occur at a time when they will be doubly costly. Increased accidents will mean an increased loss in life and limb and an increased insurance rate to provide compensation for these unfortunates. All of which means that industry will be taxed with a heavier burden in respect to compensation than is usually the case.

Employers and workmen are beginning to study the compensation laws as they never did before. Workmen are looking to them as a possible haven in case misfortune should overtake them, while employers are making closer calculations as to the burdens that they will likely be called upon to bear. In this study of the acts, no better thought could be kept in mind than that expressed by Justice Pitney in the case of *White versus New York Central Railroad Co.*:

Compensation under the act is not regulated by the measure of damages applied in negligence suits, but, in addition to providing medical, surgical, or like treatment, it is based solely on loss of earning power, being graduated according to the average weekly wages of the injured employe and the character and duration of the disability, whether partial or total, temporary or permanent.

* * *

PROGRAM OF WAR LABOR ADMINISTRATION

Secretary of Labor Wilson denies that there is any real labor shortage in this country, and says that the scarcity of workers in some places is due entirely to the improper distribution of the men and women available. As a means of remedying this condition, the plan suggested by the Council of National Defense has been adopted. This provides for the establishment of the following six agencies:

1. A means of furnishing an adequate and stable supply of labor to war industries. This will include a satisfactory system of labor exchanges; a satisfactory method and administration of training of workers; an agency for determining priorities of labor demand; agencies for dilution of skilled labor as and when needed.
2. Machinery for the immediate and equitable adjustment of disputes in accordance with principles to be agreed upon between labor and capital and without stoppage of work.
3. Machinery for safeguarding conditions of labor in the production of war essentials; this will include industrial hygiene, safety, woman and child labor, etc.
4. Machinery for safeguarding conditions of living, including housing, transportation, etc.
5. Fact-gathering body to assemble and present data, collected through various existing governmental agencies or by independent research, to furnish the information necessary for effective executive action.
6. Information and education division, which has the functions of developing sound public sentiment, securing an exchange of information between departments of labor administration, and promotion in industrial plants of local machinery helpful in carrying out the national labor program.

Some of these agencies are already in existence and for several months the Labor Department has been quietly preparing for its employment work. It is now covering the entire continent with a network of labor exchanges and is utilizing

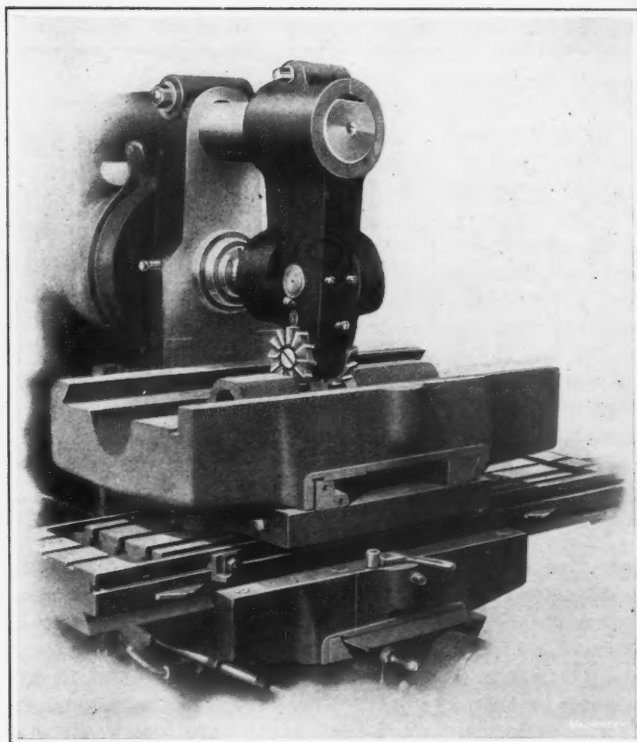
the facilities of state and municipal employment offices and the facilities of the various state councils of defense. Already more than two hundred exchanges are in operation and fifty more are to be opened immediately. The department estimates that it must furnish, within the next six months, 1,000,000 workers for agriculture, 400,000 for shipbuilding, 1,000,000 to man the ships, 250,000 for transportation, and 250,000 for munition manufacture. Other war industries will demand a similar number of workers.

John Lind, former governor of Minnesota, has been made chairman of the Advisory Council that will assist in the carrying out of this program. The other members are: Waddill Catching, president of the Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., and A. A. Landon, general manager of the American Radiator Co., to represent the employers; John B. Lennon, of Illinois, and John J. Casey, of Pennsylvania, to represent the employees; Dr. L. C. Marshall, of the University of Chicago; and Agnes Nestor, of Chicago.

* * *

MILLING MACHINE ATTACHMENT FOR FACING FEED NUT ABUTMENTS

In the manufacture of milling machines of the knee type it is necessary to provide some means for facing off the abutments that hold the table feed nut in position in the saddle. These abutments are cast integral with the saddle, and the problem is to machine them square with the axis of the screw



Kempsmith Special Milling Attachment for facing off Feed Nut Abutments

and to a specified width. A common method of machining them is to employ a boring-bar with a facing attachment. The boring-bar is used to bore the hole and face the ends at the same setting. However, this is a slow and rather unsatisfactory device for the purpose, being unsuited to straight manufacturing. Moreover, it makes necessary the use of a lathe or similar machine tool that requires considerable floor space.

The illustration shows a milling machine fixture used by the Kempsmith Mfg. Co., of Milwaukee, Wis., for facing the abutments on the saddle of the Kempsmith machine. The attachment consists of a bracket mounted on the over-arm that carries at the lower end a short spindle, on which are mounted two milling cutters, one at each end. This spindle is driven by a train of gears from the main spindle. The cutters are set with their faces the distance apart required for the length of the nut that fits between the abutments, and the saddle is fed upward until the cutters are sunk to the required depth. The attachment is also used for facing the outer ends of the abutments.

MANUFACTURING TIME FUSE RINGS¹

CHARACTERISTICS OF SOME MACHINES FOR ROUTING POWDER GROOVE

BY DONALD A. BAKER²

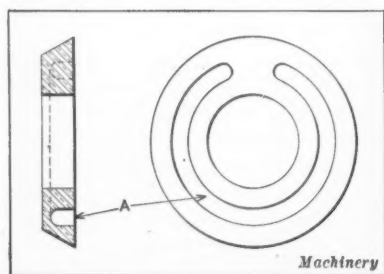


Fig. 1. Type 80 Time Fuse Ring

OF the many parts that make up a time fuse, the brass timing ring, a typical example of which is shown in Fig. 1, proved one of the most difficult to manufacture on account of the accuracy required in the machining of the powder train groove A.

When the first contracts for time fuses were given out in this country at the beginning of the war, there were no machines on the market that were especially designed for this class of work, so it was necessary for each manufacturer to adopt such machines as came nearest to the requirements and could be purchased in the open market or design and build his own, and in either case it was a matter of experiment. To some it looked like a simple proposition, and machinery in quantity was purchased that was thought suitable but had not been first tried out. Results were anything but satisfactory from a

became a serious matter when side thrust was applied. It was also found that every change of temperature, such as would occur from the high spindle speeds and the heat of the cut, transmitted to the surrounding metal was sufficient to affect the setting of the machine and produce spoiled work.

There was a special machine on the market having a ball bearing spindle very little different and no stronger than the average drill spindle. The stops which controlled the length of the groove were inconveniently placed and entailed considerable trouble in setting. The work-table had bearings that were hard to adjust and constantly out of adjustment. Altogether the drilling machines before described were more satisfactory than this machine, which was soon abandoned by the manufacturer and the user as far as possible.

Next came a horizontal type of machine, also having a ball bearing spindle. With the work and cutters running dry and with a low production of thirty or forty rings per hour, these machines gave fair satisfaction, but as soon as it was attempted to speed them up and oil or compound was used to keep the cutter cool, the fine brass chips would work back into the spindle ball bearings, in spite of felt washers or other means provided to keep them out, and in a short time the

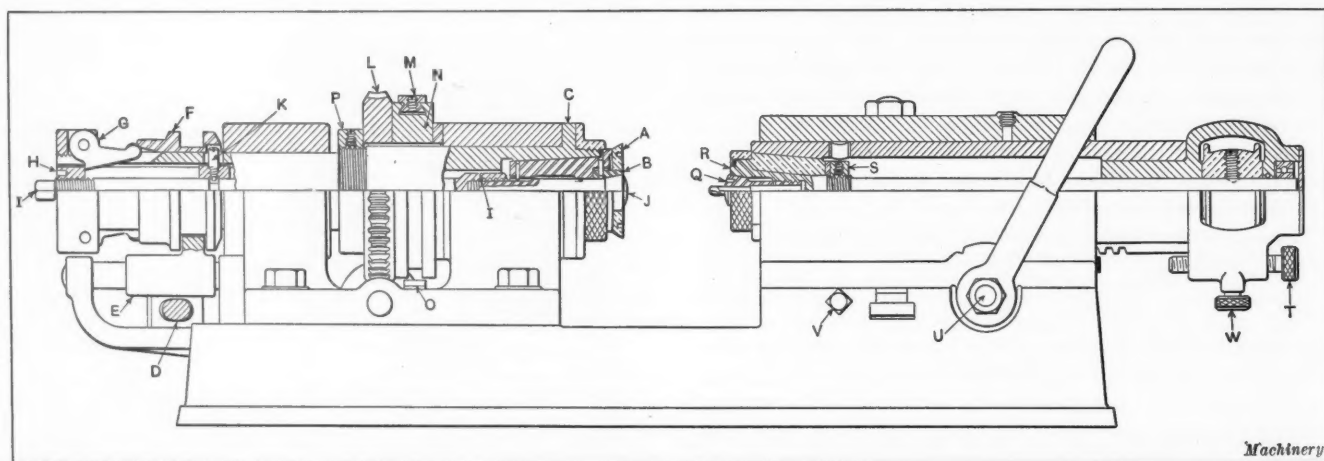


Fig. 2. Machine for routing Powder Groove

productive point of view, and in the majority of cases the manufacturers, instead of looking around for better means of producing the parts and discarding what was obviously inefficient machinery, struggled along, spending a great deal of money in making changes in the various parts, which in some instances amounted to practically as much as the original cost of the machine, and more than would have been required to design and build entirely new and efficient machines.

One of the manufacturers on the early contracts adopted high-speed drilling machines to which had been fitted suitable rotating and chucking equipment. These machines were used for taking a light finish cut, the groove having been previously roughed out on a special machine, using a circular cutter instead of an end-mill. When the machines were put into use, trouble developed in the ball bearings that carried the lower or cutter end of the spindles, due to the unusual side thrust to which these machines were subjected. The ball bearings were replaced by solid bronze bearings, and hardened and ground spindles were used. After the spindle trouble had been reduced to a minimum, it was found that the machines lacked rigidity, the great amount of overhang in all the parts, the large number of gibs, slides, etc., all contributing to this condition. While this was of little account in a drilling machine in which the thrust is all in a vertical or end direction, it

ball bearings were ruined. Replacing the ball bearings in the front end of the spindle housing with solid cast-iron or bronze bearings, and substituting a hardened and ground spindle with double taper bearing surfaces such as are used in high-grade bench lathe spindles solved the spindle trouble. But the machine was still handicapped by inconvenient stops and chucking arrangements, and also by an elaborate overhanging spindle or chuck-driving mechanism. As an illustration of their inconvenience, it may be mentioned that the operators usually kept a piece of wood handy to use as a mallet or pinch-bar for operating the chuck and stops. Fifty to sixty rings per hour was the production of these machines, as attempts to produce more usually led to considerable trouble and loss of time from adjustments and repairs. Another machine that was put on the market might have been a success but for its work and cutter chucking arrangements. The cutter-spindle

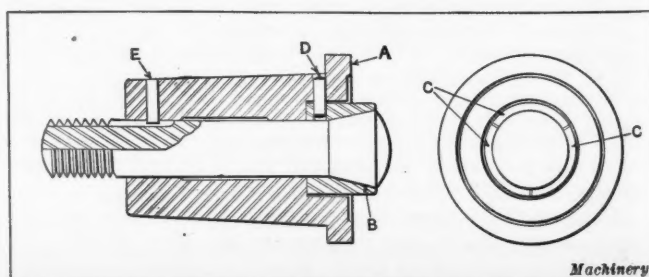


Fig. 3. Expansion Chuck for holding Time Fuse Ring

¹For other articles on fuse manufacture and allied subjects published in MACHINERY, see "Ring Turning, Facing and Serrating Machine," October, 1917; "Gages for Time Fuse Parts," August, 1917; "Fast Indexing Drill Jig for Time Fuse Cap," July, 1917; "Manufacturing Parts of Type 80 Time Fuses," December, 1916, and other articles there referred to.

²Address: Care of Anderson Forge Machine Co., Detroit, Mich.

was of good design, except possibly a little heavier than necessary. The chuck which held the cutter, however, could not be depended upon to hold the cutter true, while the chuck for holding the work was not satisfactory. Nevertheless the machine was of rigid construction, and when the cutter ran true, produced good work. As a matter of fact, one Canadian concern, after remaking the machine as regards the chucking arrangements, obtained very good results.

In view of the foregoing, and with full knowledge and experience with the various methods, the machine shown in Fig. 2 was designed. It is essentially a single-purpose machine, built with rigidity, accuracy and durability as a basis of a continuous and uniform product, and for speed and convenience of operation and adjustment, so that the maximum production would be obtained. The problems presented were simply these: the rapid, accurate, and secure chucking of the time fuse ring; the accurate and positive chucking of a suitable cutter; a spindle for carrying the cutter and its chuck which would be so stiff that it would not spring out of line due to the side thrust of the work, and having suitable bearings so that it could be run continuously at a speed of from 6000 to 7000 revolutions per minute; a spindle for carrying the work and its chuck, and having means of rotating it slowly at given speeds as determined by the ability of the cutter to remove metal; a suitable starting and stopping device to control the lengths of the cuts; and means of advancing the cutter to the work, stops for depth of cut and adjustments for position or diameter of cut.

The illustration shows the principal details of construction in section. A finished time fuse ring *A* is shown mounted on the expansion chuck *B*. The construction of this chuck is better shown in Fig. 3. It consists of a body *A* of tool steel, hardened and ground, an expanding mandrel *B* and the three expanding jaws *C*, hardened and ground. Mandrel *B* is lapped to a good sliding fit in *A*. The jaws are held in the body of the chuck by three pins *D* that are driven into the chuck body but are a free fit in the jaws. The expanding mandrel passes through the jaws, has a bearing at both ends of the chuck body and is kept from turning by the key *E*, which is driven through the chuck body and engages with a keyway cut at the end of mandrel *B*. The assembled chuck is fitted into a taper in the front end of the work-spindle *C*, Fig. 2. The chuck is opened and closed by means of the hand-lever *D*, which operates the slide *E* and the spool *F*, which, in turn, acting through the fingers *G* and the nut *H*, draw back the rod *I* and also the expanding mandrel *J*, to which rod *I* is attached. To make sure that the chuck releases properly when the hand-lever *D* is pulled in the opposite direction, carrying the spool *F* with it, the spool strikes the pins *K*, which project through slots in the work-spindle. These pins engage with a groove turned in the draw-rod, so that the spool, striking against them, is sure to push rod *I* forward, which, in turn, will force the expanding mandrel out a slight distance so that the chuck jaws will close and release the work.

The work-spindle is rotated by means of a worm and worm-gear *L*, the worm being driven by means of a round rawhide

or leather belt passing over a grooved pulley. Two stops *M*, one for starting and the other for stopping the rotation of the spindle and controlling the length of the powder groove, are carried on the drum *N*, a groove being turned completely around it and cut away at one place to allow the inserting of the stops. These stops are held in place by headless set-screws, which force them out against the angle of the groove, giving them a wedging action and holding them securely. As the spindle revolves the stops strike against the sliding pin *O*, which is held up by a coil spring but is operated and thrown out of engagement, allowing the spindle to continue its travel, by means of a foot-treadle placed conveniently to the operator's left foot. Adjustment for end play of the spindle is made by means of the nut *P*. Adjustment for wear of the work-spindle hardly had to be taken into consideration on account of the slow speed and ample bearing surface, but, as a precaution, one side of the bearings was split along the center line with a one-eighth-inch milling saw, and a metal shim inserted; then holes were drilled and tapped through it and cap-screws inserted before the bearings were bored, so that, if necessary, a slight amount of adjustment may be had by removing the shims and thinning them down a little and replacing.

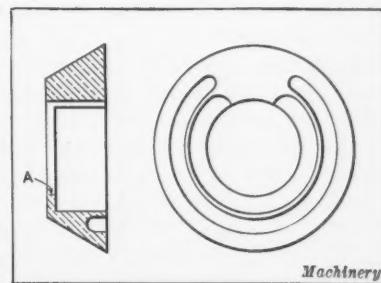


Fig. 5. Type 85 Time Fuse Ring

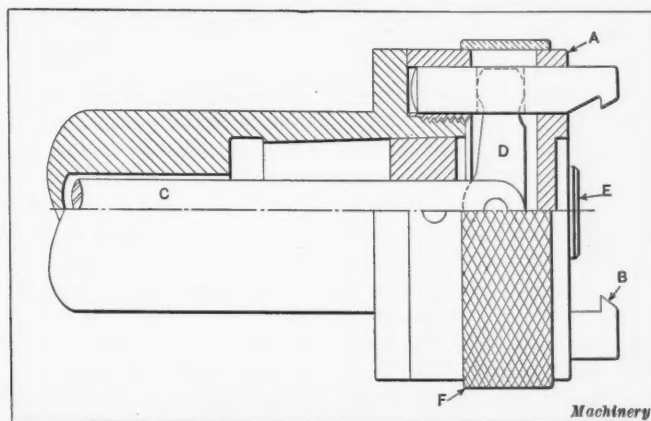


Fig. 6. Chuck for holding Type 85 Time Fuse Ring

fit the holes in the chuck and a hole through it to pass over the cutter, is used to tighten the chuck. This method also eliminates any danger of buckling the spindle from tightening a draw-rod through the center of it. As a stop for the back end of the cutter, and also to provide a positive drive without having to screw the chuck into the spindle with unusual force, the cutter is made as shown in Fig. 4, having a slot at the back end, while a hardened steel pin is driven into the back end of the collet, as shown, and pinned securely in place.

The spindle *R*, Fig. 2, has a double taper and is made of high-carbon machine steel, pack-hardened and ground all over. It is carried at the front end by a bronze bushing, ground to fit the double tapers on the spindle, the spindle being carefully lapped to a perfect fit in it. Small felt pads, inserted into holes drilled through the bottom of this bushing and connected by oil-grooves from the spindle housing, insure a continuous and plentiful supply of oil for the spindle. The end play of the spindle is taken up by means of the nut *S*, which is placed just back of the front bearing, while a hardened washer is keyed to the spindle between the nut and the bearing, taking the wear, and in connection with a locking screw through the nut, preventing changes of adjustment. As the end play is taken up so near the front end of the spindle, the spindle can run so hot that it cannot be touched by the hand without affecting the adjustment a noticeable amount, and as the ball bearing at the other end of the spindle has plenty of end play, the spindle always runs free, yet without any looseness. The bushing, or front bearing, is made removable.

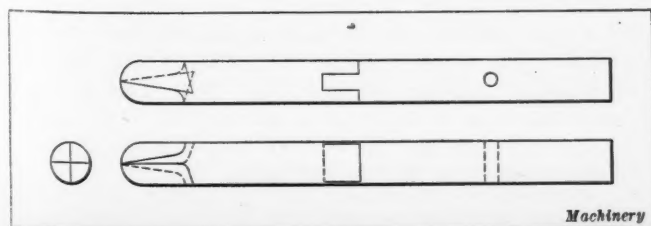


Fig. 4. Cutter and Pin affording a Stop and Positive Drive

so that in case of damage or wear it can easily be replaced. The back end of the spindle also has a bearing in the pulley housing that carries the stop-screw *T*; this screw is used to control the depth of the cut of the groove in the time fuse ring. On the outside right-hand end of the spindle housing on the under side a groove was milled, into which was fitted a rack. This rack meshes with a pinion connected through the shaft *U*, and the hand-lever is the means of advancing the cutter to the work. On the back side of this hand-lever is a simple locking device that engages with the V-groove shown, when the cutter is advanced into the work and serves to hold it there until the end of the cut.

Operation of Machine

The setting up the machine is usually accomplished by the aid of a master ring that is placed on the chuck; then the cutter is set as near to it as possible and the stops are adjusted. A blank ring is next placed on the chuck and a trial cut made and gaged. When the stops which control the length of the cut, and the cutter-head, which controls the diameter, have once been set, they need no further attention, as they will retain their setting indefinitely. The cutter-head is set by opposing screws *V* and clamped by two bolts which pass through the cutter-head casting and enter T-slots in the base. The setting for depth of cut is obtained by means of a block of proper thickness, which is held against the face of the chuck, the cutter being brought up against it and the adjustments being made by means of the knurled head screw *T* and locked by screw *W*. This adjustment needs attention only when changing cutters, as the cutters vary somewhat in length.

After the machine is properly set up, the operation is as follows: A ring is placed on the chuck by the right hand, and locked in place by operating the hand-lever *D* with the left hand. The right hand is then free to bring the lever on the cutter-head forward, and as the cutter enters the work it is automatically locked by means of the lock on the back of the hand-lever which engages with the V-groove. As soon as the lever is locked in the forward position, the foot-treadle underneath the machine is depressed, disengaging the pin *O* from the stop *M*, and the work-spindle commences to revolve and continues until the leading stop again strikes against pin *O* when the cut is completed. The lever on the cutter-head is then pushed back to the right, removing the cutter from the work, after which the foot-treadle is again depressed, allowing the work-spindle to move forward until the starting stop strikes against the locking pin *O*. During this period there is time to release the work by pulling the lever *D* forward, remove the work from the chuck, and replace it with a new piece. By this arrangement the motion of the work-spindle is almost continuous, each motion being so arranged and timed that the hands and feet follow them naturally and smoothly, hardly any exertion at all being required on the part of the operator.

To those who are familiar with the various types of machines that have heretofore been used for this class of work, particular attention is called to the simple means of obtaining all adjustments and movements, the rigidity of the construction throughout, the accessibility of the various parts, the compact construction and the almost entire lack of overhang of working parts, especially the chucks and spindles. There is also entire freedom from the use of gibs of any kind. As previously stated, the work-spindle is driven by a worm and worm-gear, which, in turn, receive their power from a round belt passing over a grooved pulley. As it is necessary that this motion be intermittent, as when the spindle revolves against the stops, some means had to be provided to take care of this. However, as the power required to drive the worm is very small, the belt is made of round leather or rawhide of just sufficient strength to furnish ample drive for the spindle, and yet to slip over the pulleys when the spindle is held from turning by the stops. The production of the machine described is about 120 brass rings per hour, such as are used on the Types 80 and 85 time fuses. The grooves are finished smooth and accurate in one cut.

The machine as illustrated is arranged to handle the Type 80 fuse shown in Fig. 1, while a different type of chuck is used

for the Type 85 time fuse ring shown in Fig. 5, this being made necessary on account of the small bearing surface on the inside of the ring *A*, which prevents the use of an expansion chuck. The chuck for the Type 85 time fuse is shown in Fig. 6; the body *A* is made of machine steel, and is bored and threaded to fit the nose of the machine spindle. The chuck jaws *B* are of hardened tool steel, are fitted into reamed holes in the chuck body, and are operated by means of the draw-rod *C* in the same manner as the expansion chuck *B*, Fig. 2, the draw-rod in this case being connected to the jaws of the chuck through an equalizing bar *D*, Fig. 6, while *E* is a hardened and ground nose piece over which the work is accurately located. The knurled sleeve *F* is used to cover over the holes made in the chuck body through which the equalizing bar *D* was inserted. The action of the chuck is as quick and positive as the expansion type, but the overhang is slightly more. This is taken care of by moving the work-head of the machine back to the left the required distance, space having been provided for it on the base as shown in Fig. 2, and suitable holes tapped in the base accordingly.

The spindle speeds recommended for brass work run between 6000 and 6500 revolutions per minute for the cutter-spindle, and one revolution per twenty-five seconds for the work-spindle. An ideal way of setting up these machines is to place six of them on a bench, back to back, three on a side. Then, with a motor-driven lineshaft running along the center underneath the bench connected to the machines, a self-contained unit is formed which may readily be moved without the necessity of having to shift overhead shafting.

* * *

CONTACT-COUPLE METHOD OF TEMPERATURE CONTROL¹

The most important step in the heat-treatment of a piece of steel is the proper control of temperature. When the kind of steel being used and the method of treatment are known, the next step is to know that it is given the treatment laid down. This is the most difficult operation in the entire process. In the first place, there is no metallic substance that will stand up under continual application of heat. Any piece of material heated from time to time, day after day, will gradually break down; therefore, it is difficult to make a pyrometer that will maintain its accuracy after it has been properly standardized for any length of time.

The contact-couple method eliminates the necessity of close standardization in the instrument for measuring heats, and can entirely eliminate the chemical checks, as far as treating the steel wrongly goes. In other words, the steel tells when it ought to be treated, and, as far as accuracy of the instrument goes, it can vary several hundred degrees and give a better result than was obtained without it. This method, when fully developed and placed on the market, will be the greatest step forward, from the standpoint of the manufacturer, that has been accomplished in the last twenty years. In this method, a standard base-metal thermo-couple is placed in contact with or in close proximity to the steel that is to be treated. In order to obtain a result, every unit of time required to heat the furnace must show an equal rise of temperature. When the decalescent point is reached, the heat that has been used in raising the temperature of the steel is consumed in the work of transforming the interior of the steel, and the temperature does not increase at the same rate as the furnace. As a result, the couple is influenced and shows a lag in temperature on the chart by a sharp deviation in the heating line.

* * *

By a more efficient use of their equipment, last May the railroads of the country carried 29,522,870,109 tons one mile, an increase of 16.1 per cent over May, 1916. This year, the average daily run of the locomotives was 71.3 miles, against 65.5 miles last year, and the average daily mileage of freight cars was raised from 28.3 to 29.6 miles.

¹Extract from an address delivered before the Steel Treating Research Society of Detroit, by F. F. Beall, vice-president of manufacturing, Packard Motor Car Co., Detroit, Mich.

ALIGNMENT CHARTS'

EXPLANATION OF PRINCIPLES GOVERNING CONSTRUCTION AND ILLUSTRATIONS OF USE

BY GEORGE L. HEDGES¹

AN alignment chart, often called a "straight-line diagram," is a form of calculation diagram that is often much simpler to make and to use than is the ordinary curve plot on rectangular axes. In its usual form, such a chart consists of three or more parallel axes, usually vertical, the number depending on the number of variables in the formula to be plotted. To use such a chart, known values on two axes are joined by a straight line, the intersection of which with the third axis gives the desired value. With a chart of more than three axes, this intersection is joined to a known value on a fourth axis by a straight line, and its intersection with a fifth axis gives the desired value. If there are more than five variables, the straight-line operation is again repeated.

Alignment charts are additive charts; therefore, a formula to be plotted with this type of chart must be expressed as the algebraic sum of functions of the variables, that is, in the form:

F(Y) = F(X) + F(Z) + . . .

The functions of the variables may be the variable itself, its products, logarithmic functions, trigonometric functions, etc. The axes are named for the variables and are graduated to the functions of the variables. The usual engineering formulas consist of the product of functions of the variables, as:

F(Y) = F(X) × F(Z) × . . .

These may always be expressed as the sum of functions of the variables, as:

Log F(Y) = log F(X) + log F(Z) + . . .

in which form they are adapted for an alignment chart. The axes are named for the variables and graduated to the logarithmic functions of the variables, the scales used depending on the formula being plotted and on the chart size desired.

To graduate the axes, decimal-divided scales with a table of logarithms are generally used. However, if many charts are to be made, a set of special logarithmic scales on different bases, say from 2 to 10 inches, will be found convenient. Decimal scales are divided into parts of an inch and numbered continuously every ten divisions; that is, one unit on the scale equals ten divisions.

Let S = scale number and

l = length of unit on scale, in inches.

Then the relation between the length of unit and the scale number of a decimal-divided scale is:

S = 10 / l, or l = 10 / S (1)

That is, on the 50 scale of an engineer's scale the length of one unit is l = 10/50 = 1/5 inch. There are, of course, any

TABLE 1. VALUES OF SCALE NUMBER AND SCALE ON ENGINEERS' SCALE CORRESPONDING TO DIFFERENT VALUES OF l

l	S	l	S	l	S	Scale to Use
100	0.1	10	1	1	10	10
50	0.2	5	2	1/2	20	20
33 1/3	0.3	3 1/3	3	1/3	30	30
25	0.4	2 1/2	4	1/4	40	40
20	0.5	2	5	1/5	50	50
16 2/3	0.6	1 2/3	6	1/6	60	60

number of possible scales, each with its corresponding value of l; but generally the 10, 20, 30, 40, 50 and 60 scales, and the 10 or 0.1 multiples thereof, are used, as these may be plotted with the ordinary triangular engineer's scale. The values of the scale number and the scale corresponding to different values of l are given in Table 1.

The principal labor in the making of an alignment chart is in arranging the lengths of the axes, or the distance along the axis between extreme graduations, so that available decimal scales may be used.

Let G = length of axis, in inches;

d = function difference, or numerical difference between extreme values of function plotted on axis.

Then:

G = ld (2)

The value of G for the longest axis determines the height of the chart. A graduated axis is used for each variable; with formulas of more than three variables, "dummy" axes, which usually are not graduated, are required. These dummy axes

TABLE 2. TABULATED VALUES FOR EXAMPLE 1

Name of Axis	Symbol	Number Limits	Logarithmic Limits	Logarithmic Difference	-	Actual Length, inches	Scale Number	Equivalent Scale	Scale to Use
Breadth	b	1 to 10	0 to 1	1	10	10	1	1	10
Depth	d	1 ³ to 10 ³	0 to 3	3	3 1/3	10	3	1	10
Moment of Inertia	I	0.083 to 833	2.921 to 2.921	4	2 1/2	10	4	4	40

represent the partial additions in the formula, and are three less in number than the number of variables.

Tabulating Data for Constructing Chart

The procedure in the making of an alignment chart can best be shown by examples. The example given in Fig. 1, the chart for a simple formula of three variables, shows the general scheme of procedure; the charts given in Figs. 2 and 3, for more complicated formulas, illustrate special features of the work. It is desirable to make use of a tabular form as shown in the examples. With a formula of three variables, the first two lines of the tabular form are used for the known variables and the third line for the unknown variable. With a formula of more than three variables, the first two lines of the form are used for two known variables and the third for a dummy axis, which represents the sum of the functions of these two known variables. The fourth line is used for a third known variable, and the fifth line for the resultant of it and the first dummy axis; and so on for additional variables. The tabular columns of the form should be filled in in the following order:

1. Name of axis.
2. Symbol. That is, the symbol of the quantity whose function is plotted. This quantity must be some function of the variable represented by the name of the axis. Constants in the formula are neglected in the tabular form; the constant serves merely to locate the position of the graduations on the intermediate axis, and this position will be determined in a more direct manner, which is explained later.
3. Number limits. Assume maximum and minimum values of the known variables and find the corresponding values of the unknown variable.
4. Function limits. The values of the functions of the variables given by their number limits.
5. Function difference. The arithmetical difference, for each variable, between its function limits.
6. Length of unit l on a decimal-divided scale, or the factor by which to multiply the function difference to get the actual length G between extreme graduations on the axis.
7. Actual length G, in inches, between extreme graduations on an axis.
8. Scale number. The scale number for an unknown variable axis is the sum of the scale numbers of the axes of which it is a resultant.
9. Equivalent scale. This is the scale which, used with the symbol with exponent omitted, will give the identical graduation as by the given scale and given symbol. The equivalent scale number is obtained by dividing the given scale number by the exponent of the symbol.

Let x = exponent of symbol;
E = equivalent scale number.

Then:

E = S / x (3)

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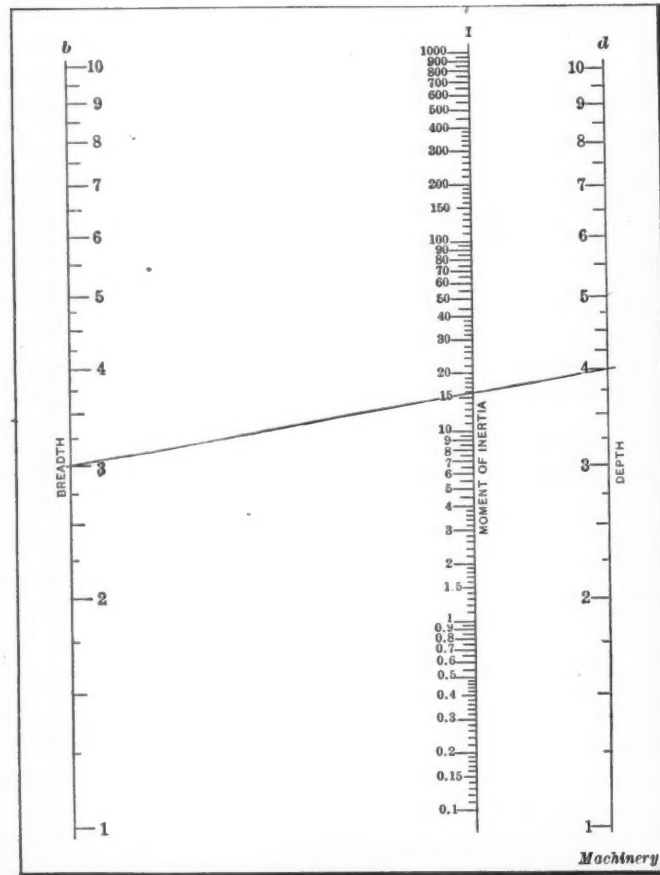


Fig. 1. Chart for determining Moment of Inertia of a Rectangle

In the chart in Fig. 3, for the axis "Gallons per Minute," the symbol is $Q^{2/5}$ and the scale number is 2; hence the equivalent scale number is 2 divided by $2/5 = 5$. This means that Q plotted with the 5 scale (the 50 scale should be used) gives the same graduation as $Q^{2/5}$ plotted with the 2 scale (using the 20 scale), and is much easier to plot.

10. Scale to use, shown by Table 1.

Plotting the Chart

A sketch should now be made showing the positions of the axes and the directions of graduations thereon, and the values of maximum and minimum numbers whose functions are plotted. The width of the chart is determined by the fact that for accurate reading the intersecting line used in reading the chart should never make an angle much greater than 45 degrees with the axes. Where it may be necessary to draw a line from the upper end of one axis to the lower end of the other, the chart should be approximately square; where the line will usually be drawn nearly horizontal, the width may be considerably less than the height. In constructing the chart, the axes should be drawn first and the limit values marked thereon.

For a formula of three variables, the axis of the unknown variable is the intermediate axis. Its distances from the outer axes are inversely proportional to the scale numbers of those axes; for example, if S_1 and S_2 are the scale numbers of the outer axes, $S_3 = S_1 + S_2$ is the scale number of the intermediate axis. Then, if D is the distance, in inches, between the outer axes, the position of the intermediate axis is:

TABLE 3. TABULATED VALUES FOR EXAMPLE 2

Name of Axis	Symbol	Number Limits	Logarithmic Limits	Logarithmic Difference	—	Actual Length, Inches	Scale Number	Equivalent Scale	Scale to Use
Principal sum	P	\$1000 to \$10,000	3 to 4	1	10	10	1	1	10
Monthly payment	$\frac{P}{k}$	\$10 to \$50	1 to 1.699	0.699	10	6.99	1	1	10
Time to pay out	$\frac{k^{(k+1)} - 1}{k^2(k-1)}$	(24 to 300) months 23.25 to 142.6	1.366 to 2.154	0.788	5	3.94	2	2	20

and

$$\frac{S_1}{S_2} \times D \text{ inches from the } S_2 \text{ axis} \tag{4}$$
$$\frac{S_2}{S_3} \times D \text{ inches from the } S_1 \text{ axis} \tag{5}$$

For a formula of more than three variables, it is necessary first to consider two known variables and find the position of the first dummy axis. Then this dummy axis is considered with another of the known variables, and the position of the second dummy axis is determined in the same manner as the first. Finally, from the last dummy axis and the last known variable, the position of the axis of the unknown variable is found.

To find the directions and positions of graduations on the axes, consider the axes in successive sets of three. The outer axes of a set will have known values, and the intermediate axis will have the unknown values. The corresponding unknown and known limit values should be at the same end of the chart. The graduation for the maximum unknown value at one end of the intermediate axis should be at the intersection of this axis with a line joining the corresponding known limit values on the two outer axes; similarly, the graduation for the minimum unknown value at the other end of the intermediate axis should be at the intersection of this axis with a line joining the other two limit values on the outer axes.

In graduating an axis, it is well first to check the chart layout by seeing if the distance between the extreme graduations

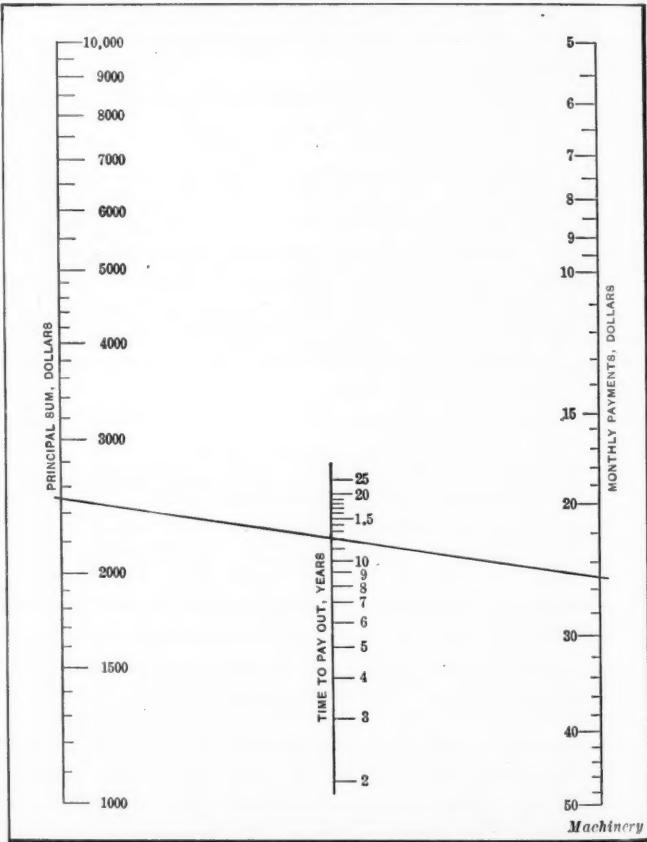


Fig. 2. Chart for determining Time required to pay, by Monthly Payments, a Given Sum with Interest

on the axis, measured with the scale from Table 1 corresponding to the scale number for the axis, equals a 10 multiple of the function difference for the axis; then lay off the graduations for 0.1, 1, 10, etc., and, lastly, fill in the intermediate graduations desired.

Example 1—Construct a chart for the formula $I = \frac{bd^3}{12}$, which is the formula for the moment of inertia of a rectangle of breadth b and depth d . In logarithmic form, it becomes $\log I = \log b + \log d^3 - \log 12$. The functions of the variables are logarithmic functions. As there are three variables, the chart has three axes; the known variables b and d are plotted as the outer axes, and the unknown variable I as the intermediate axis.

TABLE 4. TABULATED VALUES FOR EXAMPLE 3

Name of Axis	Symbol	Number Limits	Logarithmic Limits	Logarithmic Difference	<i>l</i>	Actual Length	Scale Number	Equivalent Scale	Scale to Use
Gallons per minute	$Q^{2/5}$	$1^{2/5}$ to $10,000^{2/5}$	0 to 1.6	1.6	5	8	2	5	50
Friction	$F^{1/5}$	$0.1^{1/5}$ to $100^{1/5}$	$-1/5$ to $2/5$	0.6	$16\frac{2}{3}$	10	0.6	3	30
Dummy		Not Graduated					2.6		
Length of Pipe	$L^{1/5}$	$1^{1/5}$ to $100^{1/5}$	0 to $2/5$	0.4	25	10	0.4	2	20
Diameter of Pipe	<i>d</i>	0.0786 to 31.3	2.8954 to 1.4954	2.6	$3\frac{1}{3}$	$8\frac{2}{3}$	3	3	30

The first step is arranging the matter in tabular form, as shown in Table 2. The names of the axes are Breadth, Depth, and Moment of Inertia, and the symbols are *b*, *d*³, and *I*. Maximum values of 10 inches and minimum values of 1 inch are assumed for both breadth and depth; hence the number limits will be 1 to 10 for breadth and 1³ to 10³ for depth, the corresponding logarithmic limits will be 0 to 1 and 0 to 3, and the logarithmic differences will be 1 and 3. An inspection of the formula for the example shows that the minimum limit value of *I*, the unknown variable, will be obtained from *b* = 1 and *d* = 1, for which values *I* = 0.083; similarly, the maximum limit value of *I* is found to be 833. The logarithmic limits are, then, log 0.083 = 2.921 and log 833 = 2.921; hence the logarithmic difference, which is the numerical difference between these quantities, equals 4.

For the axis Breadth, the logarithmic difference of which is 1, according to Formula (2) and Table 1, when *l* is 5, 10, or 16 2/3, the length *G* of the axis is 5, 10, or 16 2/3, respectively. Adopting the value *l* = 10, giving a length of axis of 10 inches, the chart may be plotted on paper 8 1/2 by 11 inches. For this value of *l*, Table 1 gives scale number = 1 and Formula (3) gives the equivalent scale number = 1, for which Table 1 gives 10 as the scale to use. Similarly, for the axis Depth, the logarithmic difference of which is 3, a value of *l* = 3 1/3 will be used to give a length of axis of 10 inches; Table 1 gives the scale number 3 and Formula (3) gives the equivalent scale number 1, for which Table 1 gives 10 as the scale to use. The scale number for the unknown variable *I* is then the sum of these scale numbers, or 1 + 3 = 4. Formula (3) gives the equivalent scale number 4, for which Table 1 gives as the scale to use 40.

The distance between the outer axes of the chart is made 7.2 inches, which is about as great as can be used on a letter-size sheet; hence the position of the intermediate axis is, from Formulas (4) and (5):

$1/4 \times 7.2 = 1.8$ inch from depth axis, and
 $3/4 \times 7.2 = 5.4$ inches from the breadth axis

The minimum limit value of *I* is 0.083, and the values of *b* and *d* corresponding thereto are *b* = 1 and *d* = 1. These values of *b*, *d* and *I* must be, therefore, at the same end of the chart, say the lower end, and a line

joining the value of *b* = 1 on one outer axis to *d* = 1 on the other outer axis will intersect the intermediate axis at *I* = 0.083. Laying off on the outer axes their length of 10 inches, determines the points *b* = 10 and *d* = 10, and a line joining these points intersects the intermediate axis at the maximum value of *I* = 833. If the chart is correct so far, the distance between these points for *I* on the intermediate axis, measured with the 40 scale, should equal a 10 multiple of 4, the logarithmic difference for the axis. These points determine the position of the graduations on the axis. The logarithm of 0.083 is 2.921, and of 833 is 2.921. Place the 40 scale so that 9.21 on the scale coincides with 0.083 on the axis and 49.21 on the scale coincides with 833 on the axis, and mark off the points 10, 20, 30 and 40 on the scale corresponding to values of *I* of 1, 10, 100 and 1000, respectively, on the axis. Intermediate graduations may now be marked off as desired. The alignment chart for Example 1 is shown in Fig. 1.

Example 2—Construct a chart for the formula:

$$\log \left[\frac{1}{\frac{P}{p} - \left(\frac{P}{p} - 1 \right) k} \right] = \log k$$

in which *P* = given sum, in dollars;
p = amount of each monthly payment, in dollars;
n = time to pay out, in months;
r = yearly rate of interest;
 $k = 1 + \frac{r}{12}$, constant for a given rate of interest.

The interest rate will be taken as 7 per cent, for which the value of *k* is 1.005833.

This is the formula for the time, in months, required to pay a given sum, with interest compounded monthly, by monthly partial payments made at the beginning of each month and at the end of the last month. This formula is often used in selling real estate on the pay-like-rent installment plan. This formula is not in the proper form for an alignment chart, but solving for *P/p* gives:

$$\frac{P}{p} = \frac{k^{(n+1)} - 1}{k^n (k - 1)}$$

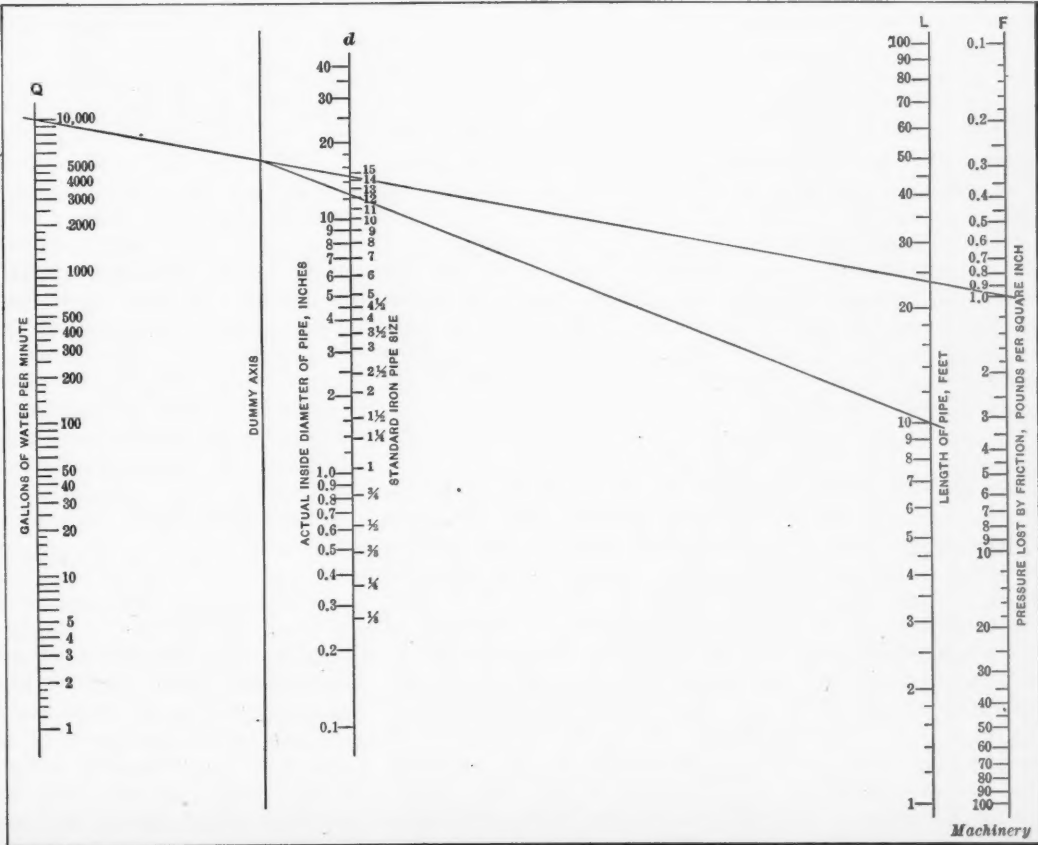


Fig. 3. Chart for determining Flow of Water in Pipes

whence:

$$\text{Log } P - \log p = \log \left[\frac{k^{(n-1)} - 1}{k^n(k-1)} \right]$$

The two known variables are P and p and their functions in the formula are logarithmic; the unknown variable is n and its function is logarithmic and is the quantity making the right-hand half of the formula. In plotting the alignment chart for this formula, the value of this function of n must be calculated for all points desired on the n scale and used for laying off these points. Table 3 gives the tabulated figures for this formula and Fig. 2 is the alignment chart. The formula gives the time in months, but the chart is marked in years. The position of the graduations on the intermediate axis of this chart were determined by finding values of P and p corresponding to the value of the function of n for maximum and minimum assumed values of n ; that is, when $n = 24$,

$$\frac{P}{p} = 23.25, \text{ and when } n = 300, \frac{P}{p} = 142.57. \text{ As is shown in}$$

the chart, it is not necessary to graduate an axis full length—only such graduations as are desired need be used.

Example 3—Construct an alignment chart for the formula for finding the diameter of pipe for a given flow of water, viz.:

$$d = \sqrt[5]{\frac{Q^3 L}{3333 F}}$$

in which Q = gallons of water per minute;

F = pressure lost by friction, pounds per square inch;

L = length of pipe, in feet;

d = actual inside diameter of pipe, in inches.

Arranging this into the proper form for constructing an alignment chart gives:

$$\text{Log } d = \log Q^{3/5} - \log F^{1/5} + \log L^{1/5} - \log (3333)^{1/5}$$

Table 4 gives the tabulated values for this example and Fig. 3 the chart. This chart is handled in exactly the same manner as the others. From Formulas (4) and (5) and from the scale numbers of the Q , F and dummy axes is found the position of the dummy axis. Then the position of the L axis is assumed, and from the scale numbers of the L axis, dummy axis and d axis the position of the d axis is found. The d axis has an additional set of graduations, showing standard iron-pipe sizes. This use of two scales on an axis will often be found convenient; for example, an axis for velocity may be graduated both in feet per second and in miles per hour.

The lines drawn on the chart to indicate the order in which the axes are used show that Q and F values, say 10,000 and 1, are joined by a straight line, and from the intersection of this line with the dummy axis a line is drawn to the value of L , say 10; the intersection of the latter line with the d axis, which is at 12 inches, gives the required inside diameter of pipe.

The size and number of graduation marks used on the axes of a chart depend considerably on the particular chart considered. In general, it will be found desirable to have the graduations between 1 and 10 repeated between 10 and 100 and between 100 and 1000, etc. The longest graduation marks should be used for the digit numbers 1, 2, 3, . . . 9, and their ten multiples; the marks for half divisions should be about two-thirds as long, and the marks for 0.1 or 0.2 divisions should be about one-third as long.

* * *

The scarcity of coal in Sweden, due to the war's having cut off the imports from both England and Germany, has made it necessary to find substitutes to be used on the Swedish railways. It has been found that ordinary pine cones, of which there is an abundance in Sweden, form a satisfactory substitute. About two tons of pine cones are required to produce the same heat effect as one ton of coal. In order to prevent the cones from burning too fast, they are mixed with coal or coke. One of the railways has used this fuel for more than a year and finds it cheaper than wood. The price paid for the pine cones varies from \$6 to \$7.50 per ton, and boys are earning from \$1.25 to \$2.50 a day picking them in the woods. Considering the fact that coal, even when obtainable, at the present time costs about \$75 a ton in the Scandinavian countries, the pine cones constitute a cheap fuel.

A SUBSTITUTE FOR BRASS

BY MARK MEREDITH¹

The high prices of copper, brass, zinc and tin, as a result of the war, have caused all nations to seek satisfactory substitutes. Many combinations of these metals have been made with lead, iron, etc., in an effort to reduce the cost, and there has been a large increase in the use of cast iron for bearings. This metal makes an excellent bearing if it is well fitted and has sufficient area, but when it begins to grip at any ill-fitted part, much mischief may be caused in a short time.

Metal is far from being the only material available for bearings. Various hard woods have been successfully used for the purpose, notably in the case of screw propeller shafts, which for many years have been made of lignum-vitæ. This wood is obtained principally from the West Indies, but increasing demands have rendered it so scarce that substitutes had to be sought. The Philippine Islands are famous for the quality and variety of their hard woods, of which the mancono is said to be the best and most durable. Lignum-vitæ is greenish brown in color and the sapwood is bright yellowish; its specific gravity varies from 1.17 to 1.39, its grain is fine and the wood fibers small and so twisted that it is difficult to split. Mancono has a brownish heartwood that turns purple when exposed to the air; the sapwood is narrow and of a pale reddish color. The wood weighs from 77 to 90 pounds per cubic foot, or 44 per cent more than water; it is double the weight of teak. Tests show that it is impervious to decay and is proof against the white ant and the teredo, or sea worm. In an official test, in which it was used in the stern tube of a steam launch that was constantly used for seven months, the commander of the naval station reported it to be quite equal to lignum-vitæ. There seems to be a field for mancono in ginning factories, both as bearings for the shafting and for the connecting-rods of gins. The latter may be made in any speed lathe, with the aid of a small circular saw and a revolving cutter.

A comparison of the friction of hard wood bearings with those of brass may be easily made. The coefficient of moving friction of a smooth plane wrought-iron surface on brass when kept perfectly lubricated with olive oil is 0.078, and of wrought iron on elm, 0.055. It is probable that mancono would have about the same friction coefficient, but would be more durable on account of its resemblance to lignum-vitæ. The durability of wooden bearings depends to a great extent on the smoothness of the metal in contact with them; therefore, the metal should be carefully smoothed. In shafting, a longer bearing might be used to compensate for the inferior hardness of the wood as compared with brass.

With brass castings at such high prices, it might be well worth the trouble for factory owners to experiment with wooden bearings and begin with the hard woods of the country that is nearest to them. India supplies a number of hard woods, including babul and the various ironwoods found in the jungles. It must not be forgotten that until the development of wheel cutting in steel and iron, which is of comparatively recent date, power was transmitted through wheels with wooden teeth and that these rendered very good service. Even today there are millions of carts in the world with wooden axles carrying merchandise long distances, and the Japanese, who are now making and exporting electrical plants and instruments of precision, are using machinery of wood to manufacture goods for export.

* * *

Stellite is now used extensively in manufacturing plants. After the surface has been ground to size, the average workman has some difficulty in recognizing the tool, unless he has some identification mark on it. However, the emery wheel will easily settle that question, as the metal is composed of non-combustible elements at grinding temperatures, and therefore shows no sparks and only a very short red streak of fire, which is developed only when the sample is pressed with considerable force against the emery wheel.—*Proceedings of Steel Treating Research Society of Detroit*

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MODERN DRILLING PRACTICE—3

AUXILIARY DRILLING HEADS AND DRILL SPEEDERS—AUTOMATIC AND SEMI-AUTOMATIC DRILLING MACHINES—TURRET TYPE DRILLING MACHINES

BY EDWARD K. HAMMOND¹

IN the operation of multiple-spindle drilling machines, where it is necessary to perform a sequence of operations in order to complete a piece of work, the development of means for attaining the highest rate of production from the machines involves taking into account the relative time required for the performance of the different operations necessary to complete drilling the work. For instance, if the piece to be machined has one short hole which can be rapidly completed and one deep hole which takes more time to drill, due consideration must often be paid to that fact in laying out the method of handling the work. If this is not done, the machine engaged in drilling the shallow hole will be idle for a substantial portion of the day, and hence will be earning only a part of the possible return on the money invested in it. An example of how provision has been made for taking care of a set of operations which vary considerably in length, is shown in Fig. 41, which illustrates a special Foote-Burt multiple-spindle drilling machine built for the Willys-Overland Co. for use in drilling two bolt holes and an oil-hole in the large end of the connecting-rods. To arrange the work so that the time required for drilling the two deep bolt holes will not represent the limiting condition, the machine was designed with five spindles and an indexing work-holding fixture.

A connecting-rod forging is put in place at the loading station, after which the fixture is indexed to bring this piece under the first pair of drilling spindles. These cut half way through the bolt holes, after which the work is indexed to a second pair of spindles which complete drilling these holes. The work is then indexed once more to bring it under a single spindle which drills the oil-hole, and the fourth indexing brings it back to the loading station, where the drilled piece is removed and a fresh forging substituted. It will be apparent that for each indexing movement one finished piece is drilled, and by dividing the drilling of the deep bolt holes between two pairs of spindles, a balance is secured between the time involved in drilling these holes and that required for drilling the oil-hole, so that none of the spindles on the machine are kept idle for a substantial length of time. The work is located on this fixture by pilots fitting into the two bearing holes that were drilled by a preceding operation, and a C-washer at the upper end secures the work without making it necessary to do more than loosen the bolt sufficiently to slip this washer out so that the work may be lifted over the nut. The material is drop-forgings and the connecting-rods are drilled at the rate of 720 per eight-hour day from each machine. The two bolt holes are 25/64 inch in diameter by 1 11/16 inch deep, and the oil-hole, which is for a 1/8-inch pipe tap, is 23/64 inch in diameter by 5/16 inch deep. The drilling operation is performed at a speed of 325 R.P.M. with a feed of 0.005 inch per revolution. The slow speed at which this operation is performed is due to the fact

that it is necessary to hold the distance between each bolt hole center and a corresponding milled surface on the connecting-rod, and if the drills are forced, there will be danger of their "running out."

Auxiliary Multiple Drilling Heads and Drill Speeders

There should be a clear understanding of the difference between the terms "auxiliary multiple drilling head" and "drill speeder." The former type of equipment is used in connection with a single-spindle drilling machine to provide for simultaneously drilling a number of holes, and the latter is employed for speeding up a small drill which is used for drilling oil-holes or small tap-holes in large castings that are being handled under a heavy drilling machine. The use of such a machine is necessary for drilling the large holes and also to provide for reaching these small holes in large pieces of work. As the spindle speeds provided on high-duty drilling machines are too slow for the efficient operation of small drills used for drilling tap-holes, oil-holes, etc., it is necessary to provide for the performance of such operations by making use of a drill speeder, which is simply an auxiliary drill head mounted on the drilling machine spindle and provided with gearing that gives the increase of speed necessary for driving small drills at the proper number of revolutions per minute.

As compared with these conditions, auxiliary multiple drilling heads may be provided with the necessary arrangement of gearing to increase the speed of the drills, to drive

these drills at the same speed as the machine spindle, or to make a variation in the speeds of different sizes of drills carried in the head. The arrangement of gearing in any drilling head will, of course, depend entirely upon the particular conditions which must be met. The spindles of auxiliary multiple drilling heads used on sensitive high-speed machines usually run at the same speed as the drilling machine spindle. The following instance is, perhaps, typical of the classes of work for which auxiliary multiple drilling heads are employed. A certain firm engaged in machining clutch rings for several different automobile manufacturers often has orders for several thousand of each kind of ring, but it may only be possible to get a few thousand drop-forgings for these rings at one time. Experience has shown that it is economical to employ single-spindle drilling machines equipped with auxiliary multiple heads for each different type of ring to be drilled. These heads can be readily interchanged to adapt the same machines for drilling different types of rings. The increased production possible with machines equipped in this way, as compared with the use of single-spindle machines, will be readily understood when it is learned that the production was increased from 290 rings per day for one man on a single-spindle drilling machine to 2700 rings per day from a machine equipped with an auxiliary multiple head. The preceding instance is typical

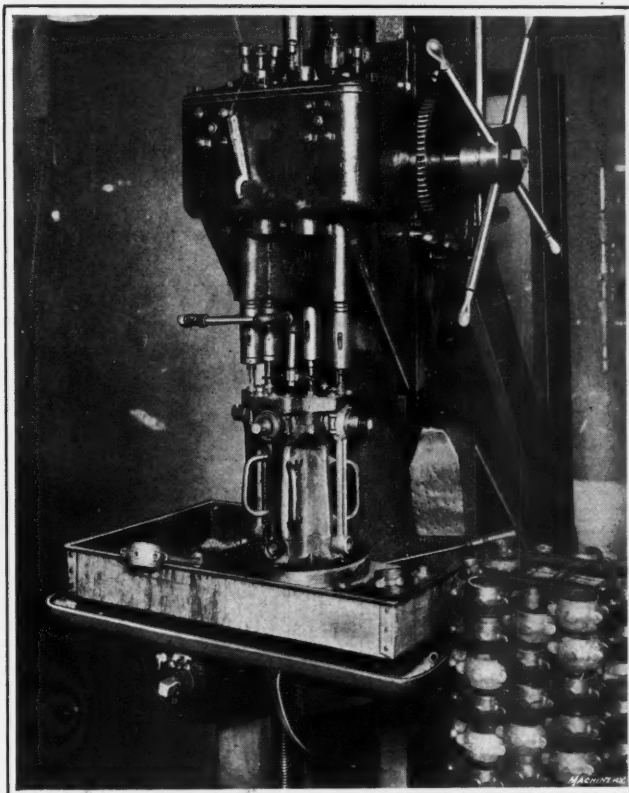


Fig. 41. Special Foote-Burt Drilling Machine built for drilling Bolt Holes and an Oil-hole in Willys-Overland Connecting-rods

¹Associate Editor of MACHINERY

of the use which is made of auxiliary multiple heads, namely, to enable a single-spindle drilling machine of moderate cost to drill several holes simultaneously. In cases where holes of different sizes have to be drilled at the same setting, it is necessary to have special gearing to provide for driving different drills at the proper cutting speeds. Fig. 42 shows a four-spindle drilling head built by the Sellew Machine Tool Co., which is used in the plant of the Peerless Motor Car Co. for machining motor cylinder blocks. In this case the drilling machine is rather heavy and the head is of correspondingly rugged construction.

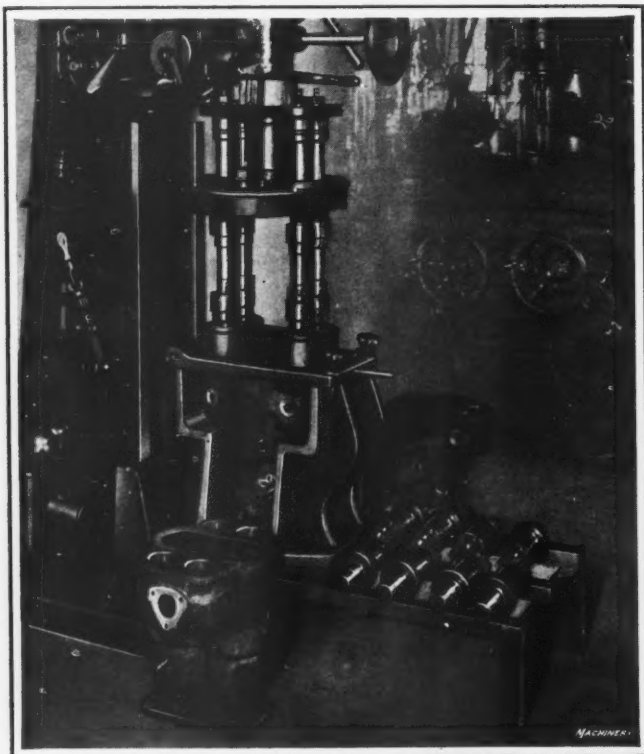


Fig. 42. Four-spindle Auxiliary Drill Head built by Sellew Machine Tool Co. for machining Peerless Motor Cylinder Blocks

Fig. 44 shows an eighteen-spindle auxiliary head that was designed and built by the Langelier Mfg. Co., for drilling and countersinking in multiples, the ninety-five holes of the center group in the radiator support shown in Fig. 43. The illustration shows a cold-rolled steel plate $1/8$ inch thick by $29/16$ inches wide and $22 1/2$ inches long. The six end holes in the plate are punched and the $17/64$ -inch holes are drilled and countersunk with the multiple head. Fig. 43 also shows the arrangement of the spindles in the drilling head. These spindles are located to correspond with every other hole in the plate in a group of thirty holes; this staggering of the spindles was necessary in order to obtain a strong spindle con-

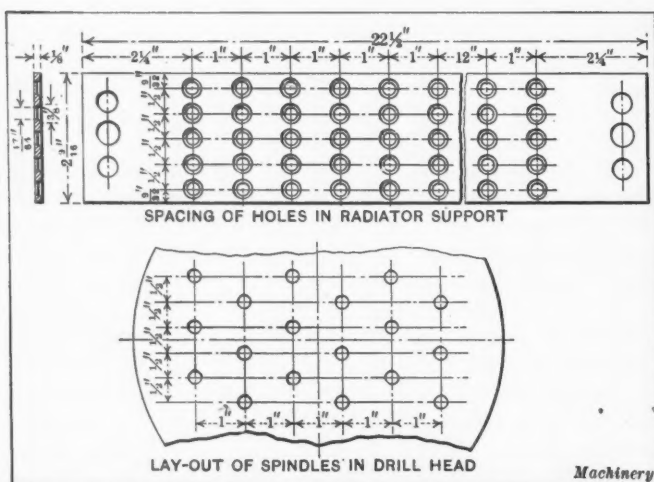


Fig. 43. Radiator Support in which Holes are drilled with Langelier Head shown in Fig. 44, by traversing Work Sidewise and Lengthwise between Successive Operations. Below is shown Lay-out of Spindles in Drill Head

struction. Each group of thirty holes in the plate is drilled and countersunk in two operations. The plate has ninety-five holes and the attachment drills them in groups of thirty holes, two operations being required to drill each group. There are three groups, and the remaining cross-row of five holes has to be drilled singly. Eighteen holes can be drilled and countersunk in five seconds. The plate is held and moved to its different drilling positions by an indexing fixture that is fastened to the table of the drilling machine. The lengthwise movement of the fixture corresponds to the shift between groups and the crosswise index to the $1/2$ -inch movement required for the two operations in each group. For each of the two operations on a group of thirty holes, fifteen of the eighteen spindles in the head are in operation and the drills carried by the other three spindles hang over the side of the work.

The tools used are a combined drill and countersink. The shanks are squared and fit into a square socket in the spindle collets. Adjustment of the tools for producing uniform countersinking is obtained by an adjusting screw that is tapped into the squared end of the tool and butts against the bottom of the square socket in the collet. This, of course, requires the tool to be taken out and may seem a slow method of adjustment, but it has been proved that, after they have once been adjusted, it is a simple matter to keep them so. The ends of the collets are taper threaded and split, and the tools are held in the collets by pinch nuts. The pinch nuts are tightened or loosened by a sleeve T-wrench which telescopes the

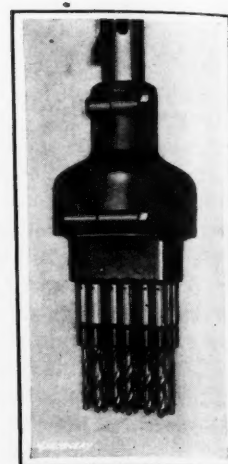


Fig. 44. Eighteen-spindle Langelier Auxiliary Drill Head

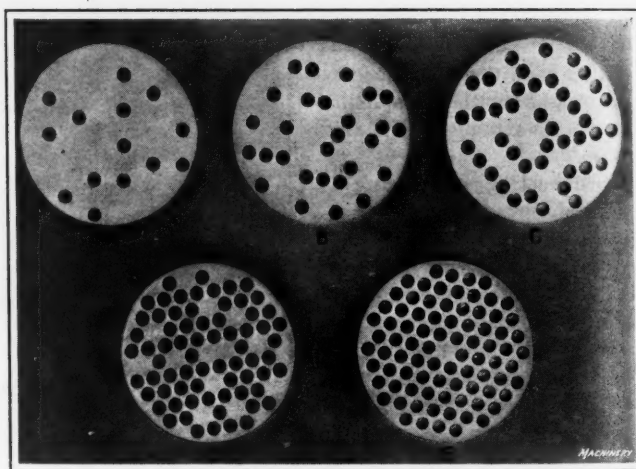


Fig. 45. Condition of Work done on Machine shown in Fig. 46 after First, Second, Third, Fifth, and Sixth Drilling Operations have been performed

tools. The drilling head is adjustable rotatively and can be set in any position in the housing without affecting its running. The housing is attached to the feed sleeve of the drill press by a clamp nut.

Indexing Multiple Drilling Machine

In a certain type of intercooler tube plate it is required to drill eighty-four $3/8$ -inch holes, and as the plates in which these holes must be drilled are only $4 1/8$ inches in diameter by $3/4$ inch thick, it will be evident that the spacing of the holes is too close to make it possible for the work to be done on any standard type of multiple-spindle drilling machine. Fig. 46 shows a special multiple-head machine built by the Langelier Mfg. Co., which is equipped with an indexing work-holding fixture; the multiple head of this drilling machine has fourteen spindles, and by indexing the work six times, provision is made for drilling all of the eighty-four holes without loss of time in removing and resetting the work or without the necessity of spending time in laying out the holes and drilling

them in a single-spindle machine. Fig. 45 shows at A, B, C, D, and E, respectively, the condition of the work after the first, second, third, fifth, and sixth drilling operations. The piece of work after the fourth operation has been performed on it is missing in this illustration. The distance between holes in the finished sheet is only $1\frac{1}{4}$ times the drill diameter, which shows how closely the drills have to be spaced. For holding and locating the work, the machine is provided with a three-jawed indexing fixture mounted on the table of the machine, and this fixture is laid out so that the work of indexing $1/6$ revolution between each of the six successive operations may be accomplished rapidly. A machine of this kind could be built with a suitable drill head and work-holding fixture to provide for drilling other pieces where the spacing of the holes is too close to make it possible for the work to be done economically on machines of standard design.

Results Obtained with Automatic Drilling Machines

There are many classes of work where automatic drilling machines may be used to extremely good advantage. As a general proposition, the work adapted for being drilled on automatic machines is of relatively small size, although this is not necessarily the case. With automatic drilling machines the high production secured is largely due to the possibility of effecting a great reduction in the idle time of the machine, as a result of means provided for continuous operation of the drilling machine spindle or spindles, and the possibility of having the operator constantly employed in removing drilled pieces from the work-holding fixture and substituting fresh blanks.

Fig. 47 shows a five-spindle semi-automatic drilling machine built by the Detroit Tool Co. The machine shown is used in the factory of the Willys-Overland Co., and it will be seen that two spindles are engaged in drilling a cross-hole in hood catch stems, while the other three spindles on the machine are employed for drilling a longitudinal hole in the end of torsion yoke pivot pins. In each case the work is secured in a cam-operated V-block fixture which is tightened or loosened by a single movement of the binding lever. The five spindles on this machine are controlled by a cam-actuated feed mechanism arranged in such a way that the spindles are advanced to the work in consecutive order. This makes it possible for the operator to be constantly employed removing drilled pieces and substituting blanks in the work-holding fixtures, and by

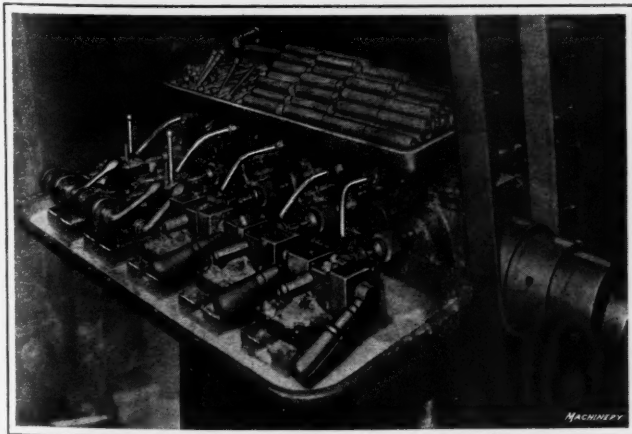


Fig. 47. Five-spindle Semi-automatic Drilling Machine built by Detroit Tool Co. Machine is shown in Operation in Willys-Overland Plant

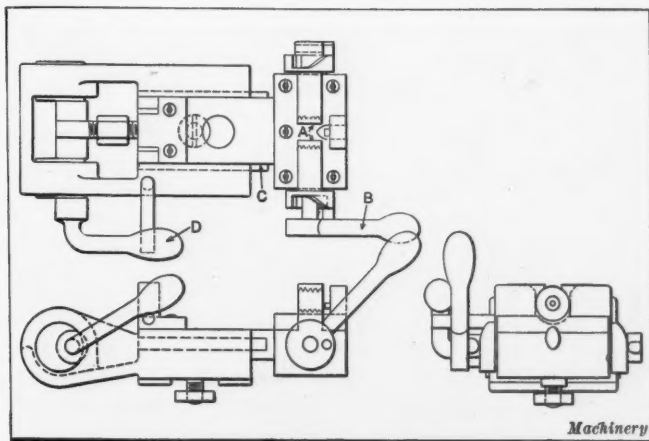


Fig. 48. Fixture for Use in drilling Deep Holes on Machine shown in Fig. 47

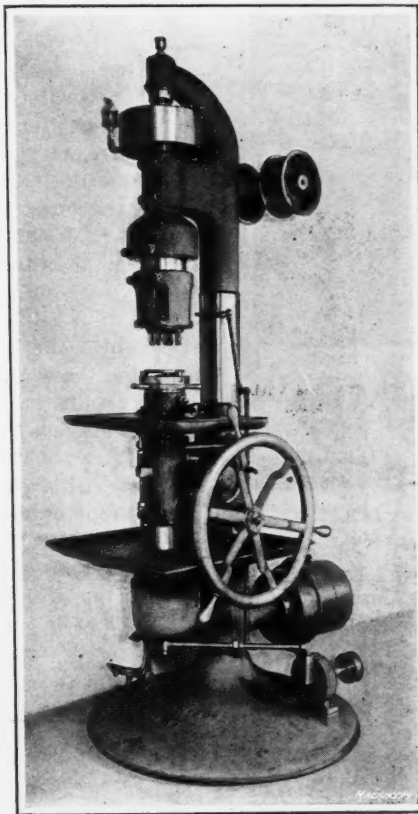


Fig. 46. Langellier Multiple Drilling Machine with Indexing Fixture to locate Work for Six Successive Operations required to drill Eighty-four Holes, as shown in Fig. 45

the time he has reached the fixture at the right-hand end of the machine, the piece in the fixture at the extreme left has been drilled and the spindle withdrawn; consequently the operator can start right in again removing drilled pieces and substituting blanks, this order being kept up continually. On the hood catch stem the cross-hole is drilled with a No. 21 drill (0.159 inch in diameter) and the hole is $11/32$ inch deep. The drills are operated at 990 revolutions per minute with a feed of 0.002 inch per revolution; the use of this low speed is necessary on account of the larger sized drills used in the other three spindles of the machine. The production is 3600 pieces in an eight-hour working day. In drilling the longitudinal hole in the torsion yoke pivot pin, the hole is drilled to receive a $3/8$ -inch tap and is $9/16$ inch in depth. The machine is operated at the same speed and feed employed for the previous operation, although the feed is really too light for this size of drill. The production is 3600 pieces per eight-hour working day.

Fixture for Increasing Feed Range

In Fig. 47 the five-spindle semi-automatic drilling machine built by the Detroit Tool Co. is shown engaged in the performance of drilling operations on two classes of pins, but it must not be inferred that the scope of this machine is in any way restricted to the drilling of cylindrical shaped pieces. Where

suitable work-holding fixtures are made, this machine is adapted for drilling pieces of a great variety of shapes and sizes, and in all cases advantage is taken of the ability of keeping the operator constantly employed in loading work into the fixtures while drilling operations are being performed on pieces held in other fixtures.

Where the pieces to be drilled are of such a character that the depth of hole required is in excess of the maximum feed movement provided by the throw of the cam, provision for drilling such pieces may be made by designing a special work-holding fixture of the general type shown in Fig. 48. This particular fixture was designed for drilling staybolts which are held in jaws A, these jaws being quickly opened or closed by means of lever B. It will be seen that the body of the fixture on which the work is supported is carried by a slide C, and provision is made for traversing this slide in a direction opposite to the feed movement of the drilling machine spindle by means of hand-lever D. In operating a drilling machine equipped with a fixture of this kind, the work is first held in the fixture with slide C in its position farthest away from the drilling machine spindle, and in this position the drill is fed

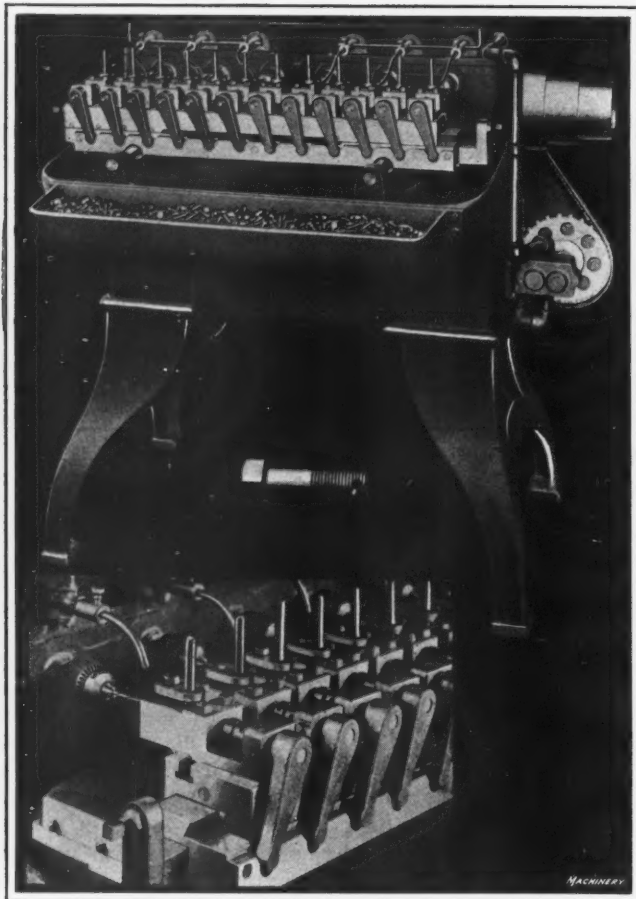


Fig. 49. National-Acme Six-spindle Semi-automatic Drilling Machine with Double Work-holding Fixture which provides for loading Six Sections of Fixture while Work is being drilled in Other Six Positions

into the work. After the hole has been drilled to the full depth in this position and the drill has been backed out of the work, slide *C* is advanced by manipulating hand-lever *D* and the fixture is secured in the forward position. Then the next time the spindle is fed forward by the cam, the drill completes cutting the hole to the required depth. Suitable fixtures of this kind can be designed to meet the requirements of a variety of classes of work where deep holes have to be drilled.

A somewhat similar type of semi-automatic drilling machine to the one previously described is shown in Fig. 49, this machine being built by the National Acme Co. It will be seen that this is a six-spindle machine, and while in general appearance it resembles the one shown in the preceding illustration, the method of operation differs considerably. On this machine all of the spindles feed forward simultaneously, and to provide for reducing the idle time of both the machine and operator, the work-holding fixture is designed to carry twelve pieces. This fixture is arranged in such a way that while six pieces of work are being drilled, finished parts may be removed from the other six work-holding fixtures and fresh blanks substituted. When the drilling operation has been completed and the drills have been automatically withdrawn from the work, the operator rocks the work-holding fixture over on its oscillating support so that the fresh blanks are brought into the drilling position. He can then remove the drilled pieces and substitute blanks in the manner previously described. Some remarkably high rates of production are secured on these machines. For instance, at the plant of the Ford Motor Co. machines of this type are employed for drilling cross-holes in bolts of the form shown in Fig. 49. In drilling a 1/8-inch hole through a 3/8-inch bolt body, the machines are operated at 1500 R.P.M., and the rate of production is 10,000 bolts per eight-hour working day. Another job performed on this machine consists of drilling a 1/8-inch hole, 9/16 inch deep, through the head of a bolt. Running the spindles at the same speed, the production is 6000 bolts per eight-hour day.

Semi-automatic Drilling Machine with Indexing Fixture

In the two preceding types of drilling machines the spindles are advanced and withdrawn automatically, but the operator

is required to manipulate the work-holding fixture by hand. In Figs. 50 and 51 there are shown two machines built by Baker Bros., which are equipped with an automatic indexing fixture. Near the top of the machine there will be seen a cam drum on which cams are mounted to provide for automatically feeding the drills into the work and withdrawing them, the amount of feed motion being regulated by the cams according to the work on which the machine is engaged. Extending down from this feed drum on the left-hand side of the machine, there will be seen a shaft which is driven by a pair of spur gears. This shaft transmits motion to an indexing mechanism located beneath the table and work-holding fixture, and by this means provision is made for continuously indexing the work-holding fixture to bring a fresh blank or blanks into the operating position to be drilled during the time that the drills are being raised ready to start the next downward stroke. With an equipment of this kind it is merely necessary for the operator to stand at the front of the machine so that he can remove finished pieces and substitute fresh blanks to be drilled.

Fig. 50 shows a machine engaged in drilling external brake-band anchors in the plant of the Willys-Overland Co. The operation consists of drilling eight 13/64-inch holes, which are approximately 3/16 inch in depth. Four holes are drilled at one end, after which the piece is reversed end for end in the fixture, to provide for drilling the other four holes. In each case the work is located in the fixture by a pilot that enters the large central hole, but alternate stations on the fixture are designed to locate the work by different methods, according to whether the first four holes have or have not already been drilled. When the piece is first set up in the fixture, it is slipped over the pilot entering the center hole, after which the lever *A* is turned to operate an "equalizer" that lines the work up properly; then wing-nut *B* is tightened, which results in raising a clamping lever that secures the work in place on the under side of the jig-plate that forms the top of the work-holding fixture. In this position the first four holes are drilled, and when the piece has again come around to the front of the fixture, the operator releases the clamps, and after taking this piece out of the fixture, sets it up again in a work-holding fixture located on the next station. In this position the work is located by a pilot entering the large center hole and by a small pin that enters one of the holes which

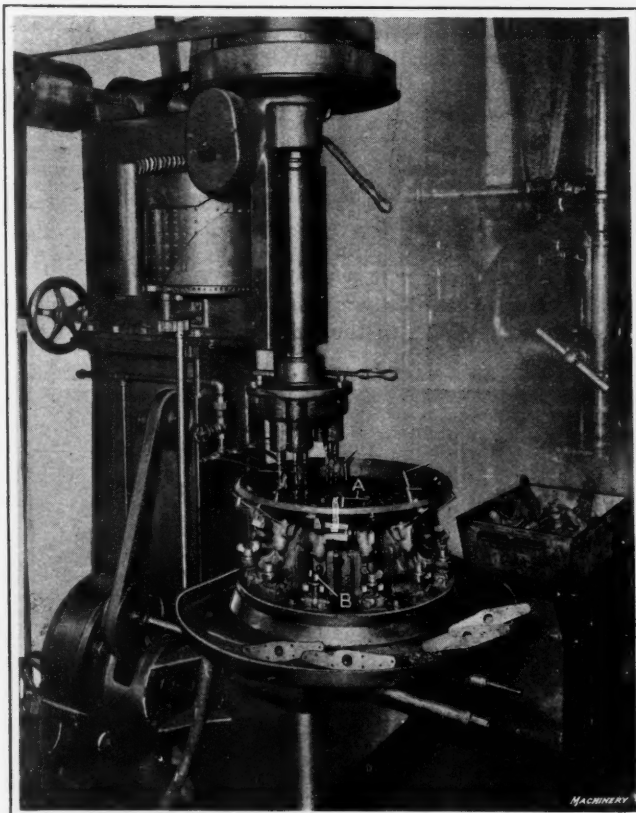


Fig. 50. Baker Bros. Semi-automatic Drilling Machine with Station Type Work-holding Fixture which is automatically indexed

have just been drilled. Then, by tightening the wing-nut *B*, the piece is clamped in place. At each downward movement of the spindle of the drilling machine eight holes are drilled—four in a piece which has already had the first four holes drilled and four in a fresh blank—so that one drilled piece is obtained for each traverse of the spindle. From this it will be apparent that the index mechanism is arranged so that the work-holding fixture is indexed through two stations on the fixture each time that the spindle of the drilling machine is raised. The machine is operated at such a speed that the drills run at 1100 R.P.M., with a feed of 0.002 inch per revolution; and operating under these conditions, 576 pieces are drilled in an eight-hour working day. The material is malleable iron.

Fig. 51 shows another application of the Baker Bros. semi-automatic drilling machines in the plant of the Willys-Overland Co. This illustration shows the operation of drilling two holes $\frac{3}{8}$ inch in diameter by 0.372 inch deep, and $\frac{25}{64}$ inch in diameter by 1.120 inch deep, respectively, in the rear axle external brake-band lever. The material is malleable iron and the operation is performed at a speed of 650 R.P.M., with a feed of 0.003 inch per revolution. The production is 600 pieces per eight-hour working day. It will be seen that the drilling machine is equipped with a three-spindle auxiliary head, but that only two of the spindles are provided with twist drills. This is not due to the fact that use is being made of a three-spindle head, but because of the necessity for drilling both right- and left-hand brake-band levers. In drilling levers of the opposite hand, the drill shown in the right-hand spindle is removed and set up on the spindle at the left hand of the central position. In the work-holding fixture used on this machine, the end of the work is located by means of a V-block, and clamping is effected by means of wing-nuts *A* which bind the outer V-block against the end of the work. Supporting pads on the fixture prevent the work from springing.

Cotter-pin Hole Drilling Machine

Fig. 53 shows a machine known as the No. 1 semi-automatic continuous-feed drilling machine, which is built by the Langelier Mfg. Co. This machine is particularly adapted for drilling small holes, such as cotter-pin holes in long pins, balls, screws, nuts, and work of a similar nature. It is built

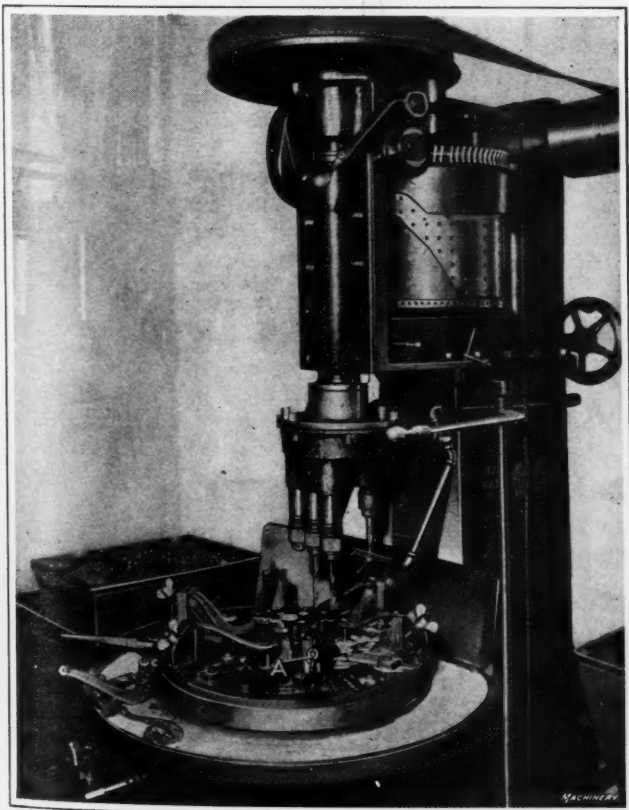


Fig. 51. Baker Semi-automatic Drilling Machine. Both this and Machine shown in Fig. 50 are in Operation in Willys-Overland Plant

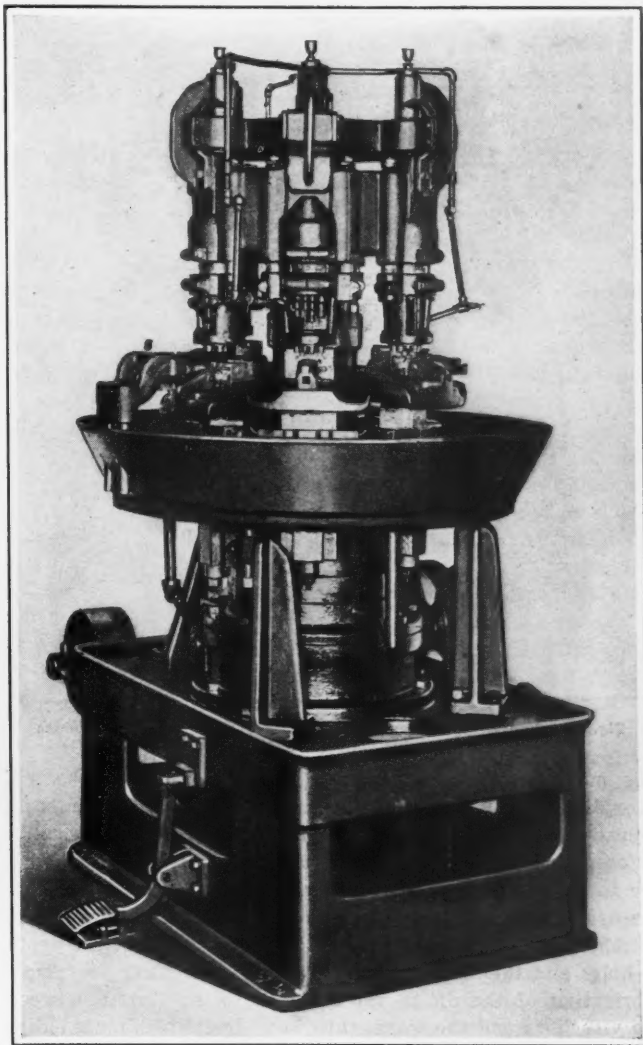


Fig. 52. Langelier Multiple-head Drilling Machine which provides for drilling Parts containing practically Any Number of Holes without Loss of Time for Ejection of Drilled Pieces or setting up Fresh Blanks

for various sizes of work, with any number of drilling heads up to and including ten. In the illustration, eight heads are shown, each head having two drilling spindles, located one above the other, making a total of sixteen drilling spindles. The piece drilled was a pin $\frac{5}{8}$ inch in diameter, having two $\frac{1}{8}$ -inch cotter-pin holes crosswise through the ends, the distance between the holes being $1\frac{21}{32}$ inch. The drilling spindles feed outward as they travel around the center of the machine, the two spindles in each head drilling the two holes in the pins at the same time. Each of the drilling heads has a vise which opens and closes automatically as it passes the operator, or may be closed by the operator with a foot-pedal, the instant he puts the work in the vise. Seven of the drilling heads are drilling continuously, while the eighth one is in the loading position, where the operator removes the finished piece and replaces a blank which is to be drilled. The drill is withdrawn as it passes the loading position and the corresponding vise opens automatically for the operator to remove the work and replace it with a blank. The operator can either sit or stand, as desired, while inserting fresh blanks in the vises. The vises are closed either automatically or by means of a foot-treadle.

All that the operator has to do is to remove the finished pieces and insert blanks in the vises, which can be made to hold pieces of various sizes and shapes. Either vertical or horizontal vises may be used, the style being determined by the class of work upon which the machine is to operate. When long pieces are to be drilled, the vises are made to hold the work in a vertical position, the work extending up any reasonable length that can be operated upon. On some classes of work an automatic ejecting device can be used to advantage, so that when the jaws open automatically the work will be forced out. With a machine equipped in this way, all that the operator has to do is to place fresh blanks in the vises.

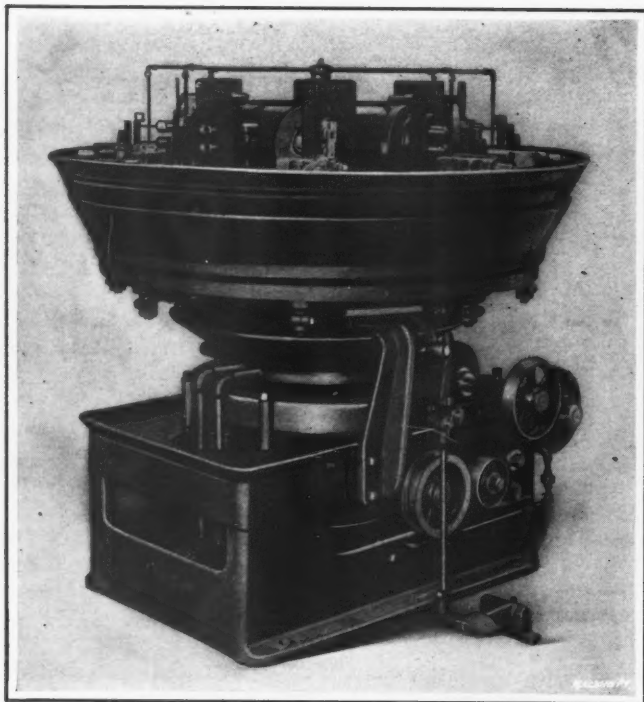


Fig. 53. Langelier Semi-automatic Continuous-feed Drilling Machine equipped for drilling Cotter-pin Holes

The maximum feed travel is $1\frac{1}{2}$ inch, and the chucks will take drills up to $1/4$ inch in diameter. The feed cam that operates the spindles is easily removed, so that cams to give different ranges may readily be substituted. When deep holes are to be drilled, the cams are made to withdraw the drills frequently, thus breaking and clearing the chips from the holes. The feed of the drills can be changed to suit the depth of holes and the sizes of drills. Provision is made for ample lubrication of the drills, the lubricant being forced between the vise jaws and the work, thus keeping the work flooded at the point of drilling so that the highest possible feed and cutting speed may be employed. A circular pan surrounds the drilling heads, this pan having ample capacity for holding the drilled work and chips. The oil is strained and drained into the base, where it is pumped back to the work by a circulating pump. An idea of the productive capacity of the machine will be obtained from the following example: Automobile chain pins $1/2$ inch in diameter are drilled with 0.121 -inch drills running at 2200 revolutions per minute, the production being 12,000 pins per ten-hour day. The capacity of the machine for round pieces with two sets of vise jaws is from $1/4$ to 1 inch, the first set taking from $1/4$ to $5/8$ inch and the second set from $5/8$ to 1 inch. The jaws carry a drill guide bushing which centers the drill accurately. These jaws can be quickly changed when it is required to operate the machine on some other class of work.

Six-head Continuous-feed Drilling Machine

Fig. 52 shows a six-head continuous-feed multiple drilling machine, with which parts containing practically any number of holes may be drilled continuously, without any loss of time for the ejection of drilled pieces or inserting blank ones. It is built by the Langelier Mfg. Co. The rate of production attained with this machine will be readily grasped upon noting that the work was drilled by an average unskilled operator at the rate of fourteen completely drilled pieces per minute, or a total of 8400 pieces or 42,000 holes in ten hours. The work is a forging $3/16$ inch thick, and there are two holes 0.199 , two holes 0.261 , and one hole 0.098 inch in diameter. The speeds for these three sizes of drills are 585, 455, and 1200 R.P.M., respectively, with a feed of 0.0018 inch per revolution. If it had been necessary that the pieces be drilled with more than five holes each, the total number of holes drilled in ten hours would have been still greater, because all the holes in each piece, no matter how great the number, are drilled in practically the same time that it would take to drill a single hole. The machine works on six pieces simultaneously and continuously.

Each head is fitted with a "steady" jig for supporting and accurately starting the drill ends. The jig is adjustable vertically to compensate for the shortening of the drills by grinding, and is also under spring tension so as to exert pressure on the work while it is being drilled. The pieces to be drilled are located and held in position by a three-point supporting pressure lever fixture, the fixture body being screwed to the table permanently. Each type of work has a separate fixture seat of its own that can be quickly removed and replaced. The pieces to be drilled are gripped by a short fulcrumed lever under spring tension, the longest end being depressed to release the work by passing under a segment cam that is located directly in front of the operator and fastened to the rim of the oil-pan. The segment cam is stationary and is adjustable vertically so as to give just the proper amount of opening. The machine consists of a box base having a vertical stationary post at the center, around which revolves a member carrying the six drilling heads and tables upon which the work-holding fixtures are fastened. Each drilling head with its table revolves in unison. The drilling feed is accomplished by the upward movement of the tables; and at the lower extremity of each table slide there is a roller having contact with a circular feed cam that is fastened to the base of the machine. The drilling is done against the tension of a spring, as a safeguard against very dull drills and incorrect chucking of work in fixtures by the operator. Tension springs pulling downward on the tables insure them having contact with the feeding edge of the cam at all times, especially on the return.

The revolving member carrying the drilling heads and tables is actuated by a Hindley worm and gear located inside of the central circular flange supporting the feed cam. The work shaft, in turn, is belted to the clutch shaft, on one end of which is a pair of miter gears that receive motion from the main driving pulley inside the box base. The drilling heads are driven by a large central gear keyed to the vertical main driving pulley shaft extending up through the central post. The driven gears on the main spindles of the drilling heads are made of compressed cotton (Fabroil gears) so as to avoid unnecessary noise and insure smooth running. A large stationary chip- and oil-pan, supported by the standards, is fastened to the base that surrounds the machine. On the outer

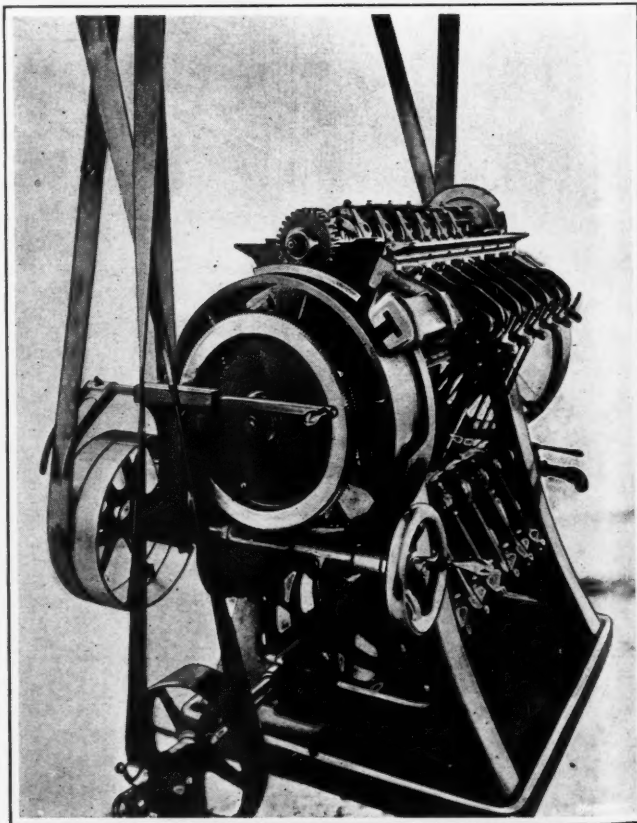


Fig. 54. Semi-automatic Machine built by Langelier Mfg. Co. for drilling Pneumatic Tire Valve Stems. On this Machine Provision is made for automatically backing out Drill at Specified Intervals to provide for clearing Chips from Hole

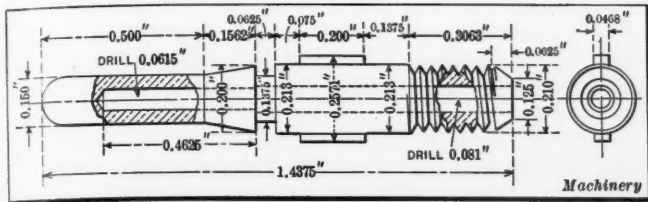


Fig. 55. Type of Brass Pneumatic Tire Valve Stem drilled on Machine shown in Fig. 54

end of the miter gear shaft is mounted a Johnson clutch that is operated by a foot-lever which is conveniently located for the operator. This clutch is used to make the circular feed of the machine independent of the driving of the drilling heads, so that it can be instantly stopped by simply unlocking the foot-lever by a side thrust of the foot.

The cutting lubricant is a special mixture that is pumped up through a tube passing through the main driving pulley shaft and then led to each drilling head by branch piping. After being used, it flows to the bottom of the circular oil-pan, where it is freed from the chips. It then passes to the top of the base, where it is filtered before entering the reservoir located in the bottom half of the base. This machine, with slight modification, can be used for drilling a large variety of pieces having one or more holes.

Semi-automatic Twelve-spindle Machine for Drilling Pneumatic Tire Valve Stems

On a machine built by the Langelier Mfg. Co. for drilling the brass stems of pneumatic tire valves, a shaft to which six fixtures are fastened is mounted in a pan supported by legs at a convenient height for the operator. These fixtures are triangular in shape, having their apexes flattened sufficiently to receive split chucks for holding the valve stems. These chucks are kept closed by springs, and are opened by small levers of such shape that when the chucks are opened by resting the palm of the hand on the levers, the work may be inserted or removed by the fingers of the same hand. The machine is shown in Fig. 54, and Fig. 55 shows the work to be drilled. The spindles, which are provided with chucks for holding the drills, run in bushed bearings in brackets attached to the outside of the pan, six on the back and six in front, and project through the pan at an angle of 30 degrees below the horizontal, thus being in line with the chucks that hold the work in the apexes of the triangular fixtures on the shaft above. There are also two larger brackets attached to the pan diagonally opposite each other, and extending out over drums at each end of the machine. These brackets support slides provided with rolls to engage with cam-plates secured to the faces of the drums. Long bars, which are attached to the slides, extend through the spindle brackets, and carry a wedge for each spindle. When these bars are drawn forward by the revolving cams engaging with the rolls on the sides, the wedges come in contact with

bushings on the spindles, and force the drills inward toward the work. The wedge bars are returned to their normal position by springs, and the wedges are separately adjustable, so that the points of the drills may be kept in line.

The two cam drums are driven by a worm belted directly from the countershaft. At every revolution of the cam drums, a wedge under the run of the right drum withdraws a spring lock-pin from a notch in the index plate on the right end of the shaft, carrying the triangular fixtures, while a toothed sector on the left drum engages with a pinion on the left end of the shaft, turning it one-third revolution, where it is locked by the pin springing into the next notch in the index-plate. A lever is provided for unlocking the fixture shaft by hand, and the cam drums may be revolved by the handwheel on the worm shaft. When the machine is in operation, the pan into which the spindles project is filled with oil, so that the drills and work are completely submerged. The oil lubricates the spindles. A large pipe with a stop-cock is provided by

which the oil may be quickly drawn off into a pail placed on the floor. The whole machine stands in a large pan, which insures cleanliness, though the drills never throw the oil, and it could only be splashed out of the upper pan by the carelessness of the operator. The valve requires to have a hole 0.081 inch in diameter drilled to a depth of 7/8 inch, and then a hole 0.0635 inch in diameter is drilled 1/4 inch farther. The cam plates on the faces of the drums are so made that the drills are fed into the work about 1/8 inch, then entirely withdrawn, and after the oil has cooled, lubricated and cleared the drills of chips, they are fed in 1/8 inch farther, and so on until the required depth is reached. The large drills are in the spindles on the back of the machine, and the small ones in front. The triangular fixtures run from front to back.

The operation of the machine is as follows: A valve stem is placed in each of the six chucks in the upturned apexes of the fixtures, then the fixture shaft is turned one-third revolution toward the back, where it is locked by the spring-pin

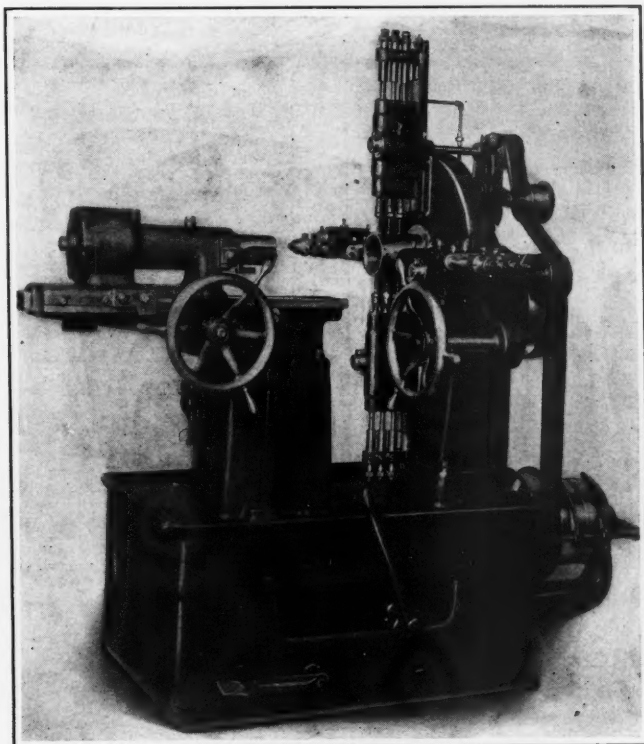


Fig. 56. Langelier Drilling Machine with Four Sets of Three Opposed Spindles for drilling Twelve 1/8-inch Oil-holes in Willys-Overland Motor Valve Sleeve

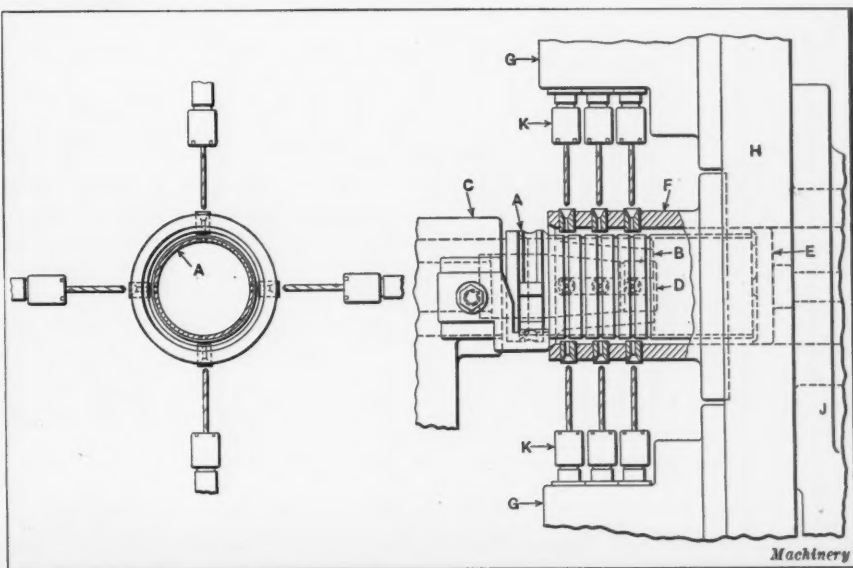


Fig. 57. Close View of Work-holding Fixture and Drilling Spindles of Machine shown in Fig. 56

in position for drilling the large holes. While the large drills are operating, the six chucks, now upturned, are filled with stems, and when the large holes are completed on the first set of stems, the fixture shaft turns one-third revolution, presenting the first set of stems to the small drills, the second set to the large drills, and the third set of chucks to the operator to be filled with stems. The machine is now fairly under way, and need not be stopped, except for accident, until working hours are over, as the operator has only to remove finished stems from the chucks, and insert blanks, while the drills are operating on the other two sets of stems. The drills make 8000 revolutions per minute, and at this speed the machine drills six valve stems every minute, or 3600 in a day of ten hours. Although designed and built for a special purpose, this machine may be adapted for a great variety of work.

Motor Valve Sleeve Multiple Drilling Machine

For use in drilling at one operation the twelve 1/8-inch oil-holes in the outer sleeve of a Willys-Overland motor valve, the Langellier Mfg. Co. designed the multiple drilling machine

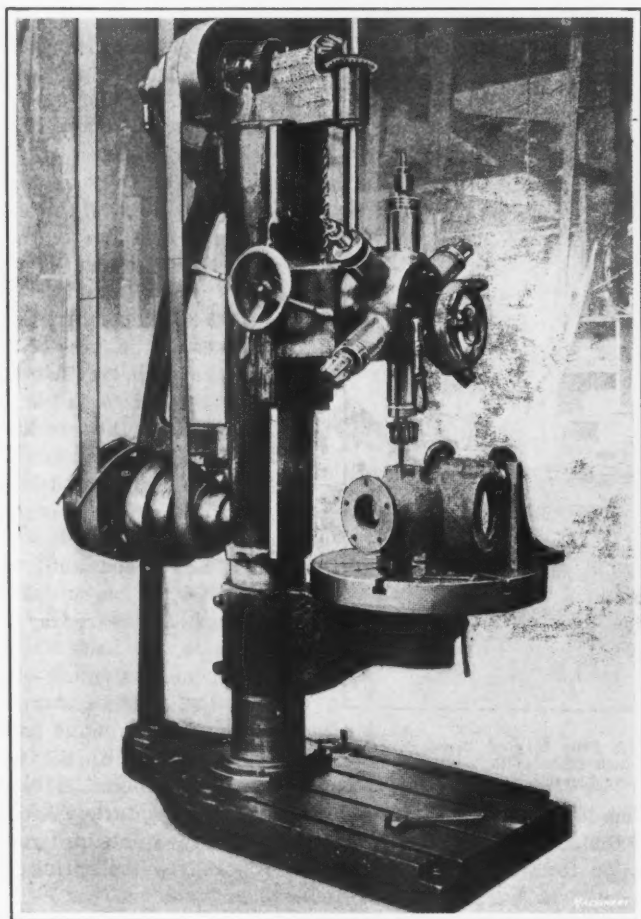


Fig. 58. Turret Type of Drilling Machine built by A. E. Quint in which Turret revolves in Vertical Plane

illustrated in Fig. 56. A similar machine was built for use in drilling four 1/8-inch holes in the inner sleeve, and the output of each machine is 3 1/2 sleeves per minute, or 2100 per day. The material is cast iron and the holes are approximately 3/16 inch deep. The machines are of exactly the same design, except that one is equipped with twelve drill spindles, while the other has only four spindles.

Fig. 57 shows a cross-sectional view through the drill jig on the machine for drilling the outer sleeve, in which the work is shown in the drilling position. Referring to this illustration in connection with the following description, the method of operating the machine will be clearly understood. Sleeve *A* is held and located in the drilling position by an internal expanding arbor *B* mounted on tailstock *C*, which slides upon ways in line with the axis of the machine. Expanding arbor *B* is opened or closed automatically by means of compressed air; the construction consists of a split sleeve that is attached directly to the piston in the compressed air cylinder; and inside this sleeve there is a fixed arbor *D* with

a tapered end that is attached to the cylinder head. A slight travel of the sleeve on this tapered portion of the fixed arbor causes the sleeve to expand and hold the work securely, extra movement being avoided by a stop collar on the sleeve and tapered arbor.

Admission of air to the cylinder is controlled by a small piston valve that is attached to the tailstock *C* at the rear and operated by contact with a fixed stop attached to the tailstock slide. The tailstock is shown in its outer or loading position in Fig. 56, movement of the tailstock slide being secured by means of the handwheel at the front of the machine. The drilling position is obtained by the sleeve to be drilled coming into contact with a stop *E* located inside drill jig *F*; this stop can be adjusted at the left-hand end of the machine. The tailstock is also automatically locked when in a drilling position, and is unlocked by the foot-treadle shown at the front of the bed; this lock is adjustable and can be set to suit the requirements of the work being drilled.

Drilling heads *G* are located radially 90 degrees apart upon a circular faceplate *H* that is mounted on column *J* attached



Fig. 59. Turret Type of Drilling Machine built by Turner Machine Co. in which Turret revolves in Horizontal Plane

to the bed of the machine. Drilling spindles *K* are driven by spiral gears, the drives extending to the rear and having pulleys on their ends. The thrust is taken up by ball thrust bearings. Feed of the drill spindles is operated by a hand-wheel at the right-hand side of the machine, which has a spur gear connection to a rim gear located inside and concentrically with faceplate *H*. The rim gear carries a segment feed cam for each head that has roller contact with the feed yoke of each drill head. These yokes have a clamp connection to the sleeve on the outer end of the drilling spindles, and this clamp connection provides ready means of adjusting the feeding position of the drill spindles.

Turret Type Drilling Machines

Turret type drilling machines fill the same place in the drilling machine group that is occupied by turret lathes in the lathe group. From this, it will be obvious that turret drilling machines are employed for the performance of a sequence of operations on a piece of work without requiring

the setting of the work to be changed. Fig. 58 shows a machine, built by A. E. Quint, in which the required series of drills, counterbores, taps, etc., are mounted in spindles carried by a turret which can be revolved to bring the required spindles into successive operation. On this machine, the design has been so worked out that the only spindle which revolves is the one carrying the tool that is in the operating position. One of the chief claims made for this type of machine is that time is saved through avoiding the necessity of resetting the work for performing a sequence of operations, and by having the entire equipment for performing these operations contained in a single unit an economy is effected in both floor space and the required investment in machine tool equipment. Fig. 58 shows one of these machines in operation, and attention is called to the fact that different types and sizes of machines are provided for the performance of various classes of work.

In the turret type drilling machines built by the Turner Machine Co., a different principle is employed for bringing the required sequence of tools into operation. Fig. 59 shows one of these machines in operation at the plant of the Greenfield Tap & Die Corporation, where it is engaged in the per-

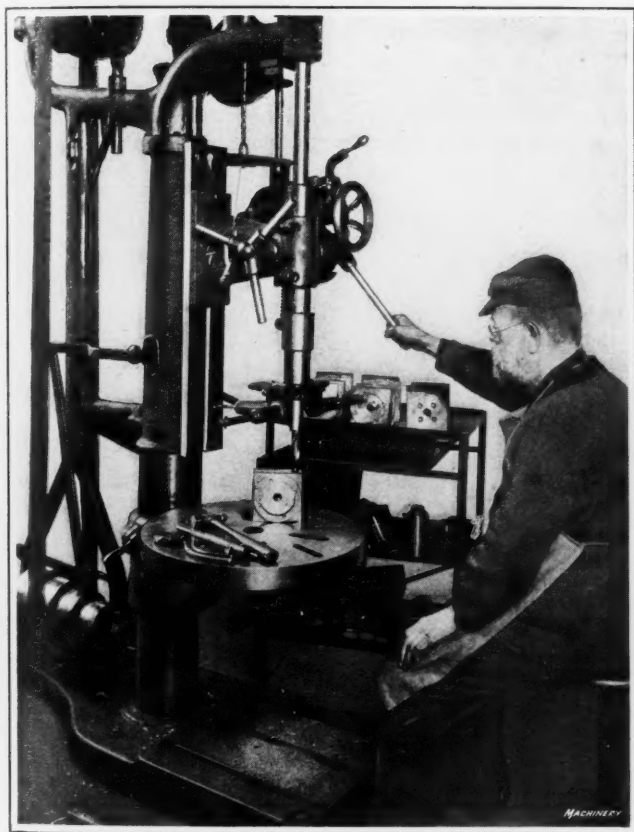


Fig. 60. Auxiliary Turret Head built by Newman Mfg. Co. to adapt Single-spindle Drilling Machine for Rapid Performance of a Sequence of Operations

formance of a series of operations on threading dies. This machine is shown drilling one hole to two different diameters, and it is necessary to ream one section of the hole. It will be apparent from this illustration that the method of bringing the different tools into operation is different from that of the machine shown in the preceding illustration. Here the turret is carried on a vertical spindle, about which it revolves horizontally to index the different spindles into the working position. Only the spindle in the operating position revolves. Machines of this type are built in different sizes, so that a suitable size may be selected for handling work covering a considerable range. These machines are designed with a turret case that holds the turret rigidly against side play, and a detent and socket positively lock the turret against rotary movement. Different styles in which these machines are built provide for driving tools fitted with Nos. 2, 3, and 4 Morse taper shanks, so that machines of this type may be used for the performance of machining operations in a wide range of work.

Another equipment of somewhat the same general type is built by the Newman Mfg. Co.; the difference between this equipment and the two preceding types is that, in the present case, a turret head is provided for use on a single-spindle drilling machine. Fig. 60 shows a machine equipped in this way, from which it will be seen that the turret head is furnished with spindles for carrying the required sequence of tools. The drive is so designed that the only tool which rotates is the one in the operating position. The different spindles are held in place by a locking mechanism and may be quickly changed to bring successive tools into the operating position. A sleeve on the head is attached to the quill surrounding the drilling machine spindle, and provides for locking the head at the proper height. These drilling machine turret heads are made in two sizes for No. 2 and No. 4 Morse taper shanks; they are also made to hold straight shanks, if so desired.

* * *

INEQUITY OF THE INCREASE IN SECOND-CLASS POSTAGE

If the heavy increase in the postage on periodicals and the establishment of zones having different rates incorporated in the War Revenue Bill (the repeal of which is proposed in the new Smoot Bill) were based on known costs of service, there would be a measure of defense for the increase. It would then have been accurate from the bookkeeper's point of view, even if inexpedient; but according to the facts, it is neither.

It has been shown that the new postage rates on magazines and periodicals like *MACHINERY* are in some instances 30 per cent higher than the express rates—although these include returns on capital invested and the profits of the express companies. Yet, the post office was not established for profits and earning power, but to serve the needs of the country. Hence, as regards the cost of service, the new rates—from 50 to 900 per cent higher than the old—are indefensible.

As regards expediency, what greater harm could be done to the nation at the present time than to stifle the means of spreading accurate information on vital subjects? The mechanical world freely acknowledges its indebtedness to *MACHINERY* for the vast amount of definite technical information this periodical has collected, verified and published on the manufacture of war munitions; and new articles relating to the making of war material are constantly being published. Information of this kind aids mechanics all over the country in making munitions that will win the war; but the post office would prevent this information from reaching as large a number of readers as possible, by the creation of prohibitive rates on magazines transmitted through the mails. One department of the government thus appears to undo what other departments in this hour of need are doing their utmost to accomplish.

The section of the Revenue Bill establishing the new second-class mail rates and zone system should be repealed. No tax should be levied on the information that reaches the producers of the country through the trade and engineering press. *MACHINERY* does not believe in the policy of bombarding members of Congress with frantic appeals to do or not to do this, that or the other; but this is a government of the people through their chosen representatives, and the people must bestir themselves to make their wishes known. Here is a blow aimed at an institution which means more to democracy than any other—an efficient periodical press circulating freely among the people of this great nation. The zone system of postage rates sets up barriers between different sections of the country when the whole purpose of our lawmakers should be to cement the people into one solid indivisible American democracy.

* * *

Machinery has been ordered and a site selected in southwestern Virginia for the new government nitrate plant. Outside of this source of supply, provisions have been made to secure a steady inflow of nitrate from Chile, and it is intended to have a large reserve of this vital raw material. Five of the enemy's steamers, which were seized when war was declared, are to be used exclusively for the shipment of nitrates.

A BRASS RECLAIMING PLANT

BY R. W. B.

The problem of reclaiming metal from the casting shop ashes and floor sweepings of the large brass manufacturing companies has been a serious proposition from the beginning of the brass industry. For a long time and up to the present some of the companies have depended on the old type of pounding mill which served the purpose to a certain extent. The real saving, however, of the modern plant, which was not taken care of by the old type of mill, is derived from what forms a large part of the "fill" or made ground in the yard of almost any brass mill in the country today. The writer has been connected with the erection and running of a modern reclaiming plant, a general lay-out of which is shown by the accompanying diagram. Considerable trouble was experienced for a year or more after the plant was installed, but after all the equipment was properly arranged and the feeds and water supply had been correctly adjusted and regulated, to obtain the proper mixture for all the machines, the final results were considered highly satisfactory, as there was a daily average of 5000 pounds of metal reclaimed. This was a very favorable showing in comparison with the old mill which was running up to the time the new mill was in operation.

While the old mill reclaimed an average of 1100 pounds of metal in twenty-four hours with a working force of eight men, or four men for each twelve-hour shift, the new mill reclaimed the 5000 pounds in ten hours with a working force of six men. The amount reclaimed by the new mill included an average of

settling tank N. The concentrates from jigs S and T are discharged to bin W, whence they are taken to a rotary dryer. After leaving the dryer the concentrates are passed over a magnetic separator where any foreign matter that would be detrimental to a good brass mixture is removed. From the separator the concentrates are sent back to the casting shop where they are melted over, the amount used being proportioned according to the grade of the mixture.

Middlings too large to move on with the "tailings" are passed off through jigs U and V back to the grinding mill. Tailings from jigs S, T, U and V are passed off through jig V and elevator X to water extractor Y, where the water is removed and the tailings are discharged to bin Z, whence they are taken, mixed with bituminous coal, and burned in the boilers or in any furnace that takes bituminous coal. After the "fines" leave the fine screen they pass off through classifier M and settling tank N to vibrating tables O and P. Here the very fine metal is separated from the coal and slag and the metal passes to bins Q and R for the finished material, while the tailings are carried to water extractor Y by elevator X. The "fines" are refined and cast into billets; they are then sent back to the casting shop to be remelted. As the tailings are used as fuel, the only loss is in the ash and dirt that float away from the water extractor. The particular advantage of the water extractor is in the saving of water, as the jigs are supplied from the water taken from the tailings. This is a great saving where water is "metered" or where a city supply is limited. This reclaiming plant, with a few alterations, could be used on any material where grinding and sepa-

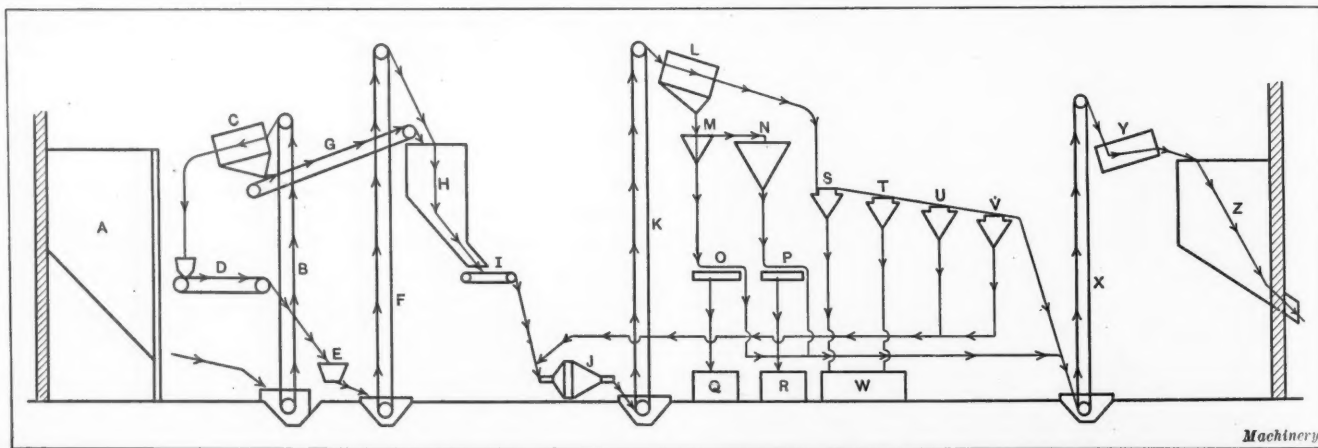


Diagram of Brass Reclaiming Plant, showing Course followed by Material

900 pounds of fine concentrates that was a total loss in the old pounding mill, which did not take care of the "fines." Nine hundred pounds of fines from a total of 5000 pounds of material, or approximately 22 pounds of "fines" per 100 pounds of material reclaimed, means a loss of 220 pounds of fine concentrates for every 1000 pounds of metal reclaimed in the old mill. With fine concentrates valued at twenty cents a pound, this would mean a saving of \$220 a day in the new plant, which would pay the operating expenses, including labor, power and supplies for eight days. The above figures are taken from the actual cost and production, and are not assumed from our running condition.

By referring to the lay-out of the mill, the course of the material in the reclamation process can easily be followed. The ashes or material to be reclaimed is fed from bin A into elevator B, which carries it to the coarse screen C, where the coarse material is separated from the "medium fine." The coarse material passes over "picking belt" D, where a man picks out the coal that is large enough to be burned at the casting shop. The fine material is carried by conveyor G to storage bin H. The coarse material, after leaving picking belt D, is carried to jaw crusher E, which crushes it fine enough to be taken by elevator F to storage bin H. The material is taken from storage bin H by an automatic feeder I to a wet grinder J. From the grinder it is conveyed to fine screen L by elevator K. At fine screen L the important separation takes place, the "middlings" passing over jigs S, T, U and V and the "fines" passing to the classifier M and to the

ration are necessary. It was the aim to reduce the metal contents of the tailings as much as possible, which we were instructed by a well-informed mining engineer would be, at best, about 1 per cent. The reclaiming plant, however, did better than was anticipated. While the tailings have at times varied from 1 to 1½ per cent metal, the general average is from 0.3 to 0.5 per cent, which may be considered a highly gratifying result.

* * *

REPORT OF THE BUREAU OF STANDARDS

The annual report of the director of the Bureau of Standards, just issued, indicates that since the war began all branches of the bureau have been conducting researches on technical problems of military application. The regular work, however, has not been overlooked. In fact, the variety and importance of the results obtained during the year in scientific and technical researches are of unusual interest. The standardization work has comprised the making of 155,000 tests of weights, measures, measuring instruments and materials. Among the many tests, those applied to gage standards for testing munition gages are of special value to the mechanical industries. In addition, a large number of researches in the physics of materials have been made. The regular growth of the scientific bureau and its special expansion on account of war work has resulted in the construction of several new laboratories and in an increase of about 60 per cent in the staff.

HAND SCRAPERS

BY C. C. MARSH¹

Owing to the growing demand, especially in the automobile and airplane industries, that all parts be finished all over, the hand scraper has become a most important tool for the machinist. These scrapers may be easily made to suit the work, but care must be taken to have them free from sharp corners and nicks on the cutting edge. As soon as a nick appears,

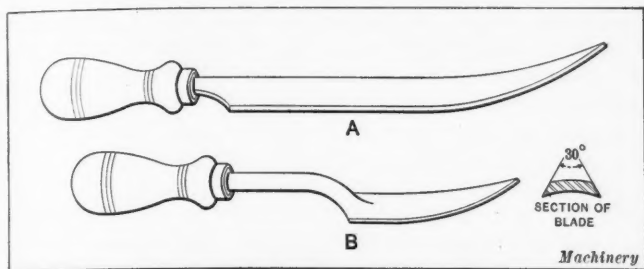


Fig. 1. Bearing Scrapers

the tool should be reground. Nicks may be caused by improper hardening, sand on the casting, dropping the tool, or grinding on too coarse a wheel. A hook scraper should not be bent over so far that it will chatter when used.

A bearing scraper may be made from an old file, provided the temper has been drawn after hardening; a good grade of tool steel is better, however, as the temper will draw more evenly and the edge will last longer. To avoid scratching, the point should have a slight radius, about 1/32 inch. The scraper may be ground on a fairly fine wheel, but a fine water grindstone is preferable. Care should be taken to have the cutting edge even and prevent it from being burned on the wheel. The scraper should not be rubbed on a whetstone, as this is likely to give an uneven edge, especially as it is difficult to whet a curved surface equally. Bearings of soft metal, such as white brass or babbitt, can be properly scraped only by a tool that has not been rubbed on a whetstone. For grinding a scraper it is a good plan to use a holder similar to that used for grinding drills. When sharpening it is unnecessary to reground the bottom face if it has been properly ground when making the tool. All sharpening should be done on the side edges.

Various widths of scrapers are required for different work. For bearings less than three inches in diameter, the scraper should be one-third the diameter of the bearing. For bearings

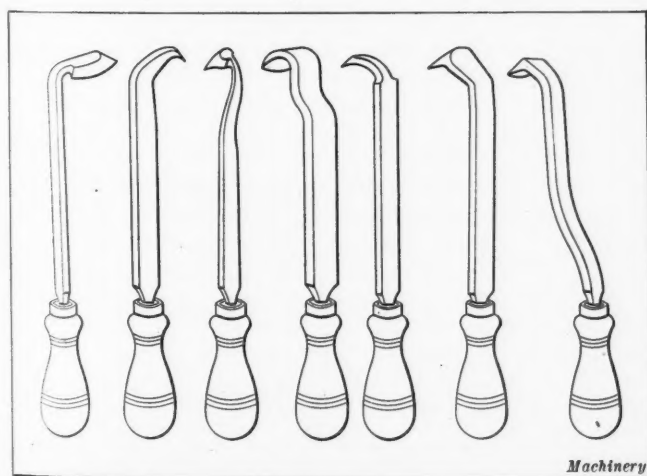


Fig. 2. Fillet Scrapers

three inches and more in diameter, a one-inch scraper should be employed, as the use of larger scrapers will be found impracticable.

There are practically only two kinds of bearing scrapers on the market. The first, shown at A, Fig. 1, costs about 50 cents and may be made from worn-out half-round files. It is curved upward at the cutting end, after being heated to the proper temperature, shaped by rough-grinding, and then re-hardened. The other bearing scraper, shown at B, has a much

shorter blade and is usually hand-forged. This tool seems to be the only one generally offered by dealers; the larger one is made only by small manufacturers. Both of these scrapers come rough and are ground by the user. The shorter scraper works much better if it is hollow-ground on the flat or under side; in fact, it is very important that this hollow be ground, as a good cutting edge is obtained much more easily and quickly than when the bottom is forged round and left rough. The curve for the hollow-grinding should be evenly made, so that it leaves a regular edge when the sides are ground. The edges should taper so that the blade is wider on the under side and should have an included angle of about 30 degrees as shown. The handles of bearing scrapers should be set firmly, but should not be too long.

Flat-plate scrapers were probably the first type used by the machinist. They are made from old flat files or forged from hexagonal or round bar stock, using the same hardening and tempering processes as are used for the bearing scrapers. They are not usually bent, though sometimes bending may be necessary for certain kinds of work. They may be whetted on the flat sides and the edges. These scrapers are used for scraping the pads and ways on various machine tools and for

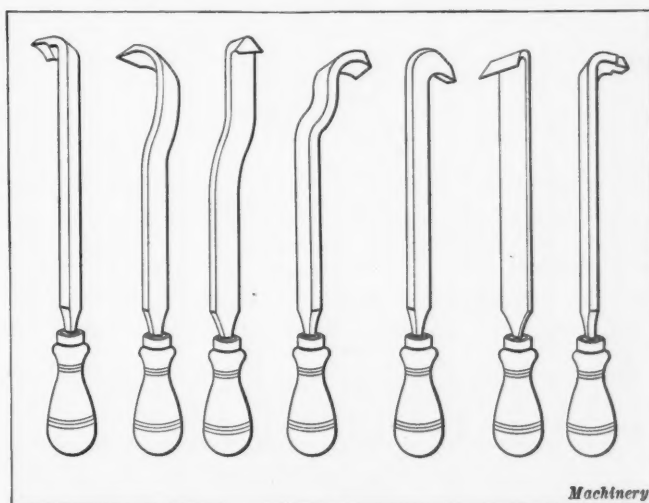


Fig. 3. Scrapers with Straight and Large Radius Cutting Edges

spotting plates and surfaces. The different designs vary in width and length, and may have rounded or square ends. The cutting edge is usually on the end. It requires more practice and skill to use these scrapers than to use the bearing scrapers.

A third class of scrapers consists of any number of styles of almost any shape, depending on the work in hand. This class may be used on such work as crankcases for gasoline motors, transmission cases, gear housings, pump housings, sheet-metal work and automobile bodies. The sand-blast finish on castings for these parts will not be uniform unless the surfaces are first scraped or polished, for all the surfaces cannot be reached by polishing. The rough and uneven surfaces should be smoothed and the scratches and marks caused by the foundry cleaning removed in order to obtain the proper results after sand-blasting. Since the practice in airplane motor construction requires that so many parts be finished all over, and since a great many pieces are so shaped that they cannot be directly machined or polished on all the surfaces, such as crankcases, gear housings, covers, etc., it is necessary for much scraping to be done. The necessity of scraping in all the corners and pockets in castings calls for an unlimited design of tools. It is impossible to design a combination of scrapers that will be suitable for all classes of work of this kind, but there are some scrapers that, properly designed, will answer many requirements. There should be a set of, say, ten fillet scrapers of various shapes. Some of these are shown in Fig. 2. The shapes shown have been used by the writer, though others would have to be designed to suit a different line of work. These sizes should vary to fit fillets of from 1/8 to 5/8 inch radius, inclusive, each size being 1/16 inch larger than the next smaller size. Some of these scrapers can be bent to reach an inside fillet and to give enough free-hand movement in scraping.

¹Address: 1338 Barth Ave., Indianapolis, Ind.

Another combination of this class should consist of bent-hook scrapers with larger radii on the cutting edges. These are for circular surfaces, such as the openings in unfinished holes, and various concave surfaces; there should also be tools with convex cutting edges for the outsides of such openings. The last combination of this class should consist of both flat and narrow square-end scrapers with both short and long hooks. Types of each of these two combinations are shown

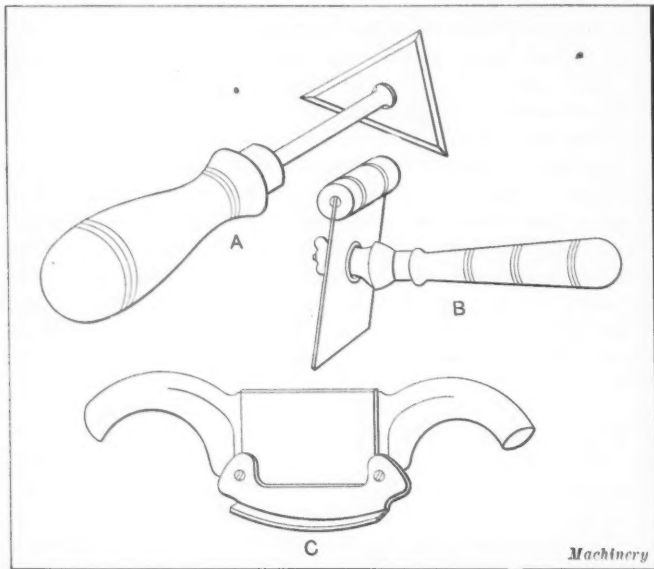


Fig. 4. Scrapers for Woodworking

in Fig. 3. Another type of scraper is the triangular or three-cornered tool. This is similar to a three-cornered file and may be made from the latter by simply grinding the three faces hollow. This scraper is used only for burring and cleaning out a hole or a closed bearing.

On all types of scrapers that are drawn toward the operator, when in use, the handles must be securely fastened to the tool. One good way is to thread the shank and use a wing-nut on the end after the handle has been slipped on. Though rather expensive, this method has the advantage that the handles, if made of hard wood, are not so likely to split.

Scrapers for the woodworking industry are shown in Fig. 4. That shown at A is used by the butcher for scraping his meat block, while at B and C are shown the packing-box and cabinet-makers' scrapers. The hand scraper for the woodworker is much more developed than is the machinist's scraper; that is, many efficient types of wood scrapers are more easily obtained from tool manufacturers, because the requirements have become known through an ever-increasing demand from the woodworking trades. It was only a few years ago that cabinet and furniture makers used pieces of broken glass to smooth the surfaces on various kinds of work. Now such a thing would be ridiculed. There is no doubt that within a short time metal hand scrapers also will become standardized, as far as requirements will permit, because of the growing demand for a final finish.

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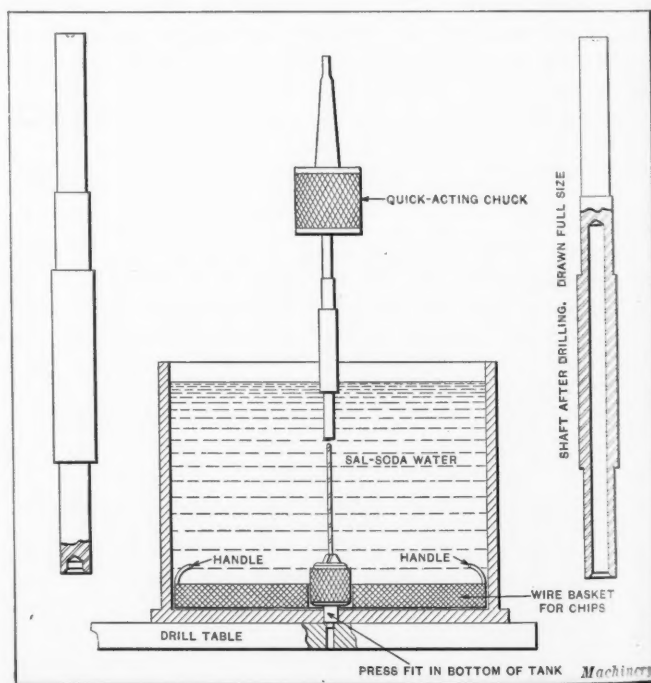
A new pyrometer has recently been developed for measuring temperatures above the range for which the thermo-couple is suitable. The pyrometer, as described in the *Electrical World*, consists of tin contained in a graphite bulb and which has an opportunity to expand through a graphite capillary tube. The expansion of the graphite is almost negligible in comparison with that of tin, and as the tin does not appreciably evaporate until a temperature of probably 2000 degrees C. (about 3600 degrees F.) has been reached, high temperatures can be negotiated with accuracy. A steel tube which contains an insulated contact is lowered into the capillary tube until it makes a contact with the surface of the tin and thus completes a circuit through an electric buzzer or sounder. The height of the tin is indicated by the position of the upper end of the steel tube, which holds a pointer moving over a scale. It will be noted that this pyrometer makes use of the principle of the ordinary thermometer.

INVERTED DRILLING OF ARMATURE SHAFTS

Deep-hole drilling is defined by one maker of drilling machines as the drilling of any hole that has a depth exceeding five times the diameter. Any drill point sunk to a depth greater than five times its diameter is likely to give more or less trouble because of the chips clogging and the difficulty of getting lubricant to the point. Deep-hole drilling as often carried out is a rather slow and costly operation. On the other hand, it is sometimes done in a very simple and efficient manner. A case in point is the practice of the Robbins & Myers Co., Springfield, Ohio, builder of electric motors, in whose plant the drilling of a 3/16-inch hole to a depth of 4 3/8 inches in a small armature shaft is done simply and effectively. The 3/16-inch hole is drilled longitudinally in the armature shaft in order to feed oil to a bearing, a cross-hole being drilled to admit the oil from the longitudinal hole to the bearing. To drill this deep hole in an automatic screw machine or speed lathe would be a troublesome and costly operation that would be bound to break many drills and spoil many shafts, but the following method gives very little trouble, and the drilling operation is reduced to a low cost.

The drilling is done on a Leland-Gifford sensitive drilling machine, which is provided with a cast-iron tank as shown in the accompanying illustration. This cast-iron tank has a hole bored in the bottom for the mandrel of a Jacobs drill chuck. Surrounding the chuck is a shallow wire screen basket which is provided to catch the chips and facilitate their removal. The tank is filled to within about one inch of the top with the sal-soda solution and the shaft is immersed in the solution when being drilled. The chuck holds a 3/16-inch drill in an inverted position and the chuck and drill thus are beneath the water level. The armature shaft is held in a Wahlstrom quick-acting drill chuck.

The operator chucks the shaft in the drill chuck, the same as though it were a drill, and feeds it to the drill with the hand-lever, pumping up and down until the full depth is reached. A short experience enables him to avoid breaking



Drilling Armature Shafts with Drill held Stationary in an Inverted Position

drills, as he becomes expert in feeling the slight additional stress when the drill begins to heat and clog with chips. The spindles are drilled at the rate of one every one and a half minute, or forty per hour.

* * *

During the ten months ending October 31, this country imported \$2,504,033,908 worth of merchandise, or nearly \$500,000,000 more than in the corresponding period of 1916. Its exports during this period were valued at \$5,150,589,085, a gain of over \$700,000,000.

MANUFACTURE OF A SELF-LUBRICATING BEARING MATERIAL

PRODUCTION OF "GRAPHALLOY" BY A METALLIZING OR IMPREGNATING PROCESS WHICH COMBINES EITHER A WHITE METAL OR BRONZE WITH GRAPHITE

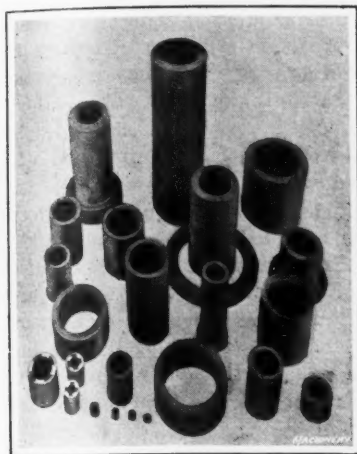


Fig. 1. A Group of "Graphalloy" Bearing Bushings

for or bronze. For many years the attempt has been made to mix or alloy graphite with metal. This proved to be difficult on account of the great difference between the specific gravity of graphite and that of any metal. Within the last few years this problem has been solved by a commercial process of impregnating porous solid graphite forms with molten metal by the application of enormous air pressures. As this process is unique, a brief description of it will be given. The product known as "Graphalloy" is manufactured by the Graphite Metallizing Corporation, Yonkers, N. Y., and is used both for bearing bushings and for brushes and contacts in connection with electrical machinery.

The first important step in the production of "Graphalloy" is the selection of the graphite, which is obtained in the form of solid bars and plates. The bars are used for making bearings and the plates for the production of brushes and contacts for electrical apparatus. These bars or plates are not pure graphite (except in the case of bearings intended for unusually light service), but contain a small percentage of carbon to strengthen the graphite and make it more durable. It is essential to secure graphite which is uniform in texture and of a porous nature. The amount of carbon in the graphite stock is varied somewhat according to the intended use.

The next step in the manufacture of "Graphalloy" bearings or other parts is cutting or grinding the bars or plates to whatever form is required. It might be well to explain that "Graphalloy" bearings are encased in a housing, so that the bearing proper is in the form of a bushing. These bushings are machined approximately to the required size before they are impregnated with metal, because it is much easier to cut the graphite stock than the metallized graphite. Standard machine tools are employed for this work. For instance, the graphite rods may be drilled, bored, and turned to size in a turret lathe or screw machine and grinding machines are also used to advantage in connection with this part of the work. After bearings or other parts have been metallized, they are then finished accurately to whatever sizes may be required. Grinding machines are used almost exclusively for these finishing operations. A group of bearings of various sizes is shown in Fig. 1. Some of these have been finished to size, whereas others have been metallized but not ground. The three bushings shown in the lower left-hand corner are of the encased type having a metallized graphite lining which is surrounded by a white-metal casing to enable the bearings to withstand greater shocks.

Metallizing or Impregnating Process

The graphite bushings or other parts to be impregnated with metal are first heated in a crucible in one of the two oil-burning furnaces illustrated in Fig. 3. This preliminary heating is done at a relatively low temperature, and while one

furnace is used for this purpose the other is melting whatever metal is to be used. As soon as this metal is molten, it is poured into the crucible containing the heated graphite parts. The crucible contains a perforated plate which is placed on top of the pieces to be impregnated and serves to keep them submerged in the molten metal. As soon as the metal has been poured in, the temperature of the furnace is increased to the maximum in order to superheat the metal. For instance, copper which has a melting point of about 1940 degrees F. is heated to approximately 3000 degrees F., so that it will remain in a molten condition and not become sluggish during the metallizing process.

When the metal has been heated sufficiently, the crucible is lifted out of the furnace by an electric hoist and is placed upon a small car which conveys it to the hydraulic press shown in Figs. 2 and 3. The crucible is placed on top of a hydraulically operated plunger (see Fig. 3), which is immediately elevated, thus lifting the crucible up into a chamber in the upper part of the press. The hydraulic plunger, which is simply used to lift the crucible and then close the lower end of the chamber to make it air-tight, is provided with a copper ring or gasket which bears against the lower end of the chamber. Practically all the air is next exhausted from this chamber, the vacuum gage recording about 28 inches. The object of exhausting the air from the enclosed chamber prior to the metallizing process is to expel the air from the pores of the graphite to insure thorough impregnation.

In two or three minutes, the valve connecting the chamber with the vacuum tank and pump is closed, and air compressed

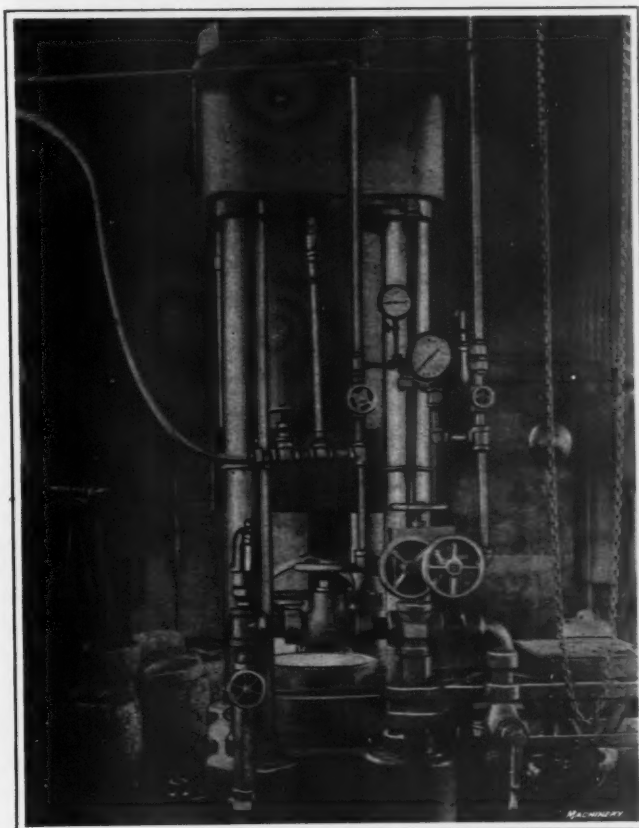


Fig. 2. Detail View of Press, showing Control Valves

to 5000 pounds per square inch is admitted to the chamber. This tremendous pressure forces the molten metal into the graphite so thoroughly that it permeates every part of a bushing or other piece. So far as we know, this is the highest pneumatic pressure that is used in a commercial way. The air is compressed in a four-stage machine (see Fig. 4) equipped with suitable intercoolers. The air pressure of the four stages is, respectively, 60, 275, 1300, and 5000 pounds per

square inch. The air pressure is also applied to the lower side of the hydraulic plunger, as otherwise it would be forced downward. The metallizing process is completed in about five minutes, which includes the time for exhausting the air and applying the pressure. The crucible is removed from the press by lowering the plunger, and then the metallized contents are either immersed in water for rapid cooling or covered with sand to obtain a more gradual cooling. The latter method is employed except in the case of very small parts which are not likely to crack as the result of sudden cooling.

The metallized parts are next finished to whatever size may be required and, as previously mentioned, this is done by using some form of grinder. In the case of bushings, the work is done on internal or cylindrical grinders, whereas such parts as brushes and contacts of electrical apparatus are finished by means of a disk grinder or a surface grinder, the exact method varying according to the size of the work and the nature of the machining operation. If necessary, the parts can be threaded or tapped the same as pieces made of brass.

The metal used for impregnating the graphite depends upon the class of work. All parts such as shaft bearings are impregnated with a white-metal alloy or babbitt metal of special composition. The parts used in connection with electrical apparatus are impregnated with a copper alloy which is also utilized for such parts as steam turbine packing rings, etc., which must withstand high steam temperatures. The use of copper for the electrical work is essential because of its electrical conductivity.

The extent to which the graphite is impregnated with the metal is indicated by the fact that the weight of the graphite

The use of "Graphalloy" is not recommended where the combination of speed and pressure is excessive. As a general rule, a bearing pressure of 50 pounds per square inch of projected area should not be exceeded. The limitations of this material are indicated by the following rule which applies to a bearing used without a lubricating oil. The surface speed of the shaft in feet per second multiplied by the pressure in pounds per square inch on the projected bearing area should not exceed a constant of about 200. The temperature of "Graphalloy" bearings is somewhat higher than that of ordinary bearings lubricated with oil, which is principally due to the fact that "Graphalloy" is a relatively poor conductor of heat. As soon as a "Graphalloy" bearing is put into service, a graphite coating begins to form on the shaft, the thickness of the coating depending upon the smoothness of the shaft. This coating soon becomes very smooth and hard, which greatly reduces the coefficient of friction and the temperature of the bearing. It is claimed that a temperature as high as 200 or 300 degrees F. will not injure the "Graphalloy" or cause it to seize the shaft. The temperatures are moderate at high speeds, provided the bearing pressure is low. On the other hand, if the bearing pressure is relatively high and the speed low or moderate, the temperature will also be low.

F. D. J.

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IMPORTANCE OF AUTOMOBILE INDUSTRY

According to a statement of the National Automobile Chamber of Commerce, \$300,000,000 worth of raw and fabricated material is used annually in the automobile industry. Part of this material is used by the 550 manufacturers of pas-

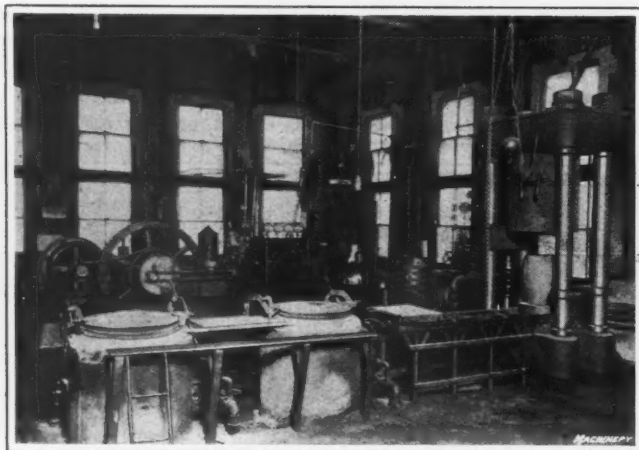


Fig. 3. Furnaces for heating Metal and Graphite, and Press in which Graphite Parts are metallized

is 0.057 pound per cubic inch, whereas the weight of the metallized product is 0.145 pound per cubic inch when impregnated with babbitt, the increase of weight due to the metallizing process being practically 150 per cent. The metal in "Graphalloy" is about 60 per cent by weight, or 25 per cent by volume. The specific gravity is 4 and the compressive strength, approximately 14,000 pounds per square inch. One important fact regarding "Graphalloy" is that it is not injured by the application of lubricant. In fact, the use of an applied lubricant is recommended when the bearings are used for rather heavy service.

Classes of Service for which "Graphalloy" is Adapted

At the present time "Graphalloy" in the form of bearings is applied to light-duty machinery operating at high speeds and to heavier service when the speeds are relatively low. Its use is recommended particularly where the application of oil is either objectionable, difficult, or likely to be neglected. These bearings are commonly applied to loose pulleys, vertical shaft bearings, conveyors, textile machinery, canning machinery, etc. They are recommended for loose pulleys in cotton and silk mills and have also been utilized successfully on paper machinery, shoe machinery, wrapping machines, cotton spinning frames, etc., which operate on a product that may be damaged by the use of oil. One of the important uses of "Graphalloy" is for vertical bearings, such as are found on governors, fans, etc.

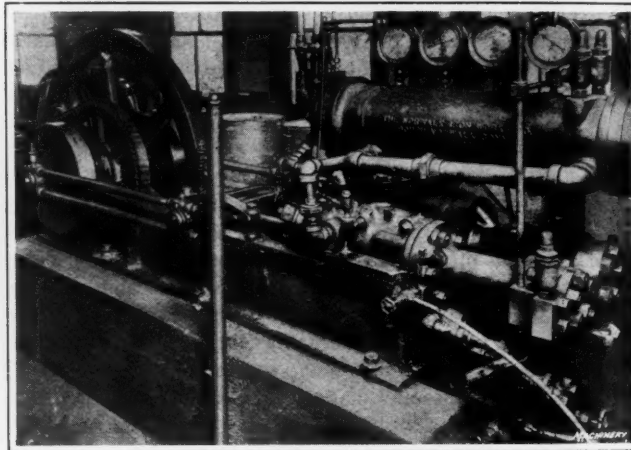


Fig. 4. Four-stage Compressor with Final Pressure of 5000 Pounds per Square Inch

senger and commercial cars, whose factories are located in 32 states. These manufacturers have an invested capital of \$736,000,000; employ 280,000 workers, to whom they annually pay \$275,000,000; and for the year ending June 30, 1917, produced 1,806,194 motor vehicles. The gross wholesale value of these cars was \$917,470,938; \$90,000,000 worth of these cars were shipped abroad. The remainder of the raw and fabricated material was used by the 1080 parts and accessory makers. These manufacturers have an invested capital of \$336,000,000 and employ 320,000 workers, to whom they annually pay \$228,000,000. During the year ending June 30, 1917, the tire manufacturers produced 18,000,000 tires, which were valued at \$450,000,000; nearly one-half of these were used on cars produced during the year. On July 1, 1917, there were in the United States 4,242,800 registered automobile owners; 400,000 of the registered vehicles were commercial cars. These cars and their supplies were sold by 27,800 distributors and dealers. The 2800 distributors have an invested capital of \$41,000,000 and annually pay their 28,000 employees \$25,200,000. The 25,000 retail dealers have an invested capital of \$184,000,000 and annually pay their 202,000 salesmen, repairmen, etc., \$159,000,000. In addition, 2255 supply houses sell the automobile owners their supplies, supplemental equipment, etc.

* * *

It is estimated that 25 per cent of the enameled, galvanized and tin household wear manufactured in this country this year will be required by the government.

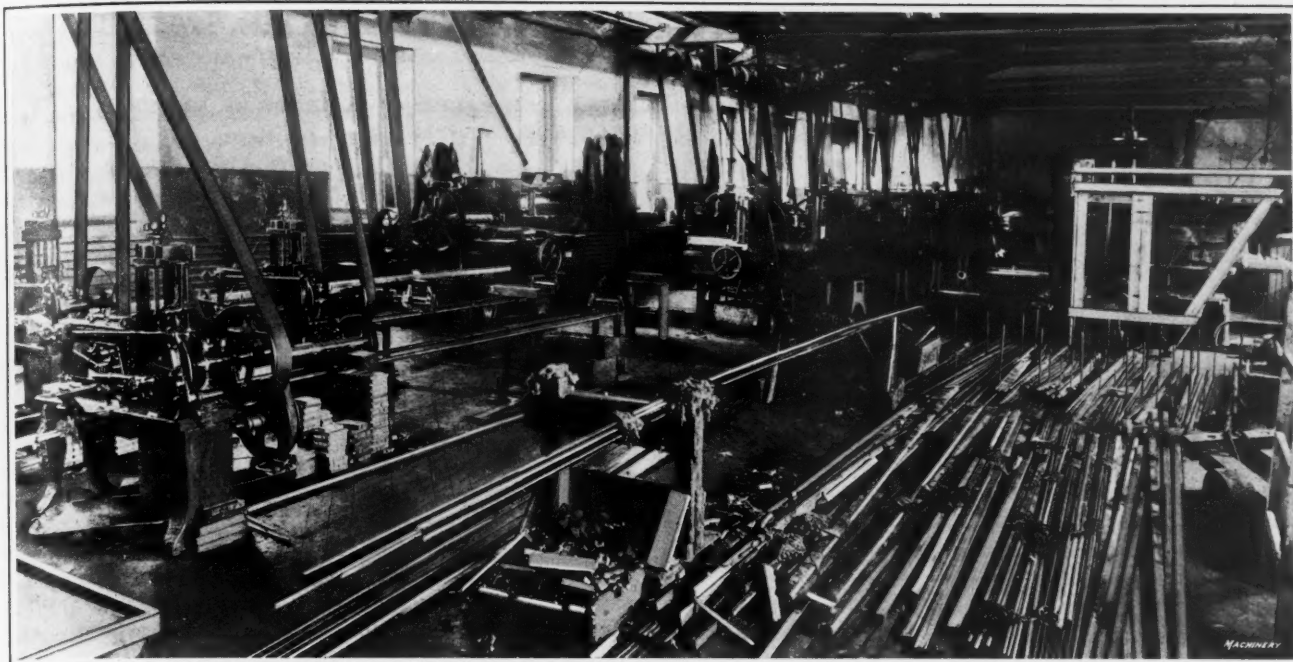


Fig. 1. General View of Department in which Keys are made

MANUFACTURE OF GIB KEYS

Cold-drawn shafting and screw stock of a variety of shapes and sizes is the principal product of the Pennsylvania Shafting Co., Spring City, Pa.; but as the manufacture of keys used for securing gears, pulleys and other machine members to shafting, is closely allied to the shafting industry, and as a superiority quality of gib keys is made from cold-drawn steel bars, this firm has a department engaged in key manufacture. The chief advantage secured through making gib keys from cold-drawn bars, is that these bars may be drawn to such a size that the machining required to complete the keys is reduced to three simple operations. The first step consists of cutting off blanks of the required length, and in order to facilitate the performance of this operation, a number of bars—usually the maximum number which can be placed in the vises of "Marvel" hacksaw machines built by the Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill.—are worked on at one time. Each of these hacksaw machines is arranged with a stop so that the bars can be set up to cut blanks of the desired length without the necessity of gaging.

After the blanks have been cut off, they are taken to special manufacturing milling machines of the type shown in Fig. 3. These are simple machines with a table which runs between housings that carry the spindle and an outboard bearing for the cutter-arbor. It will be seen that the cutter is furnished with a cylindrical section *A* which mills away the stock, leaving a portion at the end which forms the head of the key. At the same operation a small angular section *B* of the cutter mills off the corner of the head to leave it of the desired form. After milling, it is simply necessary to obtain the desired taper on the key, this taper being $\frac{1}{8}$ inch per foot for keys of all sizes. From the milling machines the keys are taken to a

Pratt & Whitney surface grinder shown in Fig. 4, which is equipped with a magnetic chuck. The keys are placed crosswise on this chuck with the heads down and overhanging the edge. The chuck is blocked up at one side so that its face is at such an angle with the grinding wheel spindle that keys ground on the chuck will be given the desired taper of $\frac{1}{8}$ inch per foot. The use of cold-drawn steel bars for the blanks from which these keys are milled, makes it unnecessary to perform a finishing operation on the sides of the keys or on the top of their heads, because a sufficiently good surface is produced during the process of cold-drawing. E. K. H.

* * *

CADMIUM FOR RUSTPROOFING

It is claimed that cadmium in combination with copper or zinc is a valuable material for preventing cast iron, wrought iron and steel from rusting. The iron or steel may be covered with a coating in the following manner: Double salts of cadmium and copper cyanide or of cadmium and zinc cyanide are dissolved in water, and the iron or steel objects electroplated in this solution; in a few minutes the objects will be covered with a coating of cadmium zinc or cadmium copper. The coating is silver-colored and permanently protects against rust. The double-salt solution may be made by dissolving 1 part of cadmium hydroxide and 1 part of copper oxide in 100 parts of water. Cyanide of soda or of potassium is added to the solution. If zinc instead of copper is wanted in the coating, zinc oxide is used instead of the copper oxide. Objects to be coated are first cleaned in a diluted acid solution, and are then placed as the negative pole in the solution. For the positive pole a zinc or copper plate is used. Five amperes for each square foot of area to be covered, with a pressure of four volts, is claimed to have been found satisfactory.

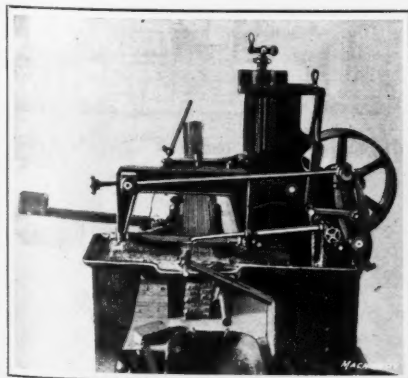


Fig. 2. Cutting off Key Blanks on "Marvel" Hacksaw Machines built by Armstrong-Blum Mfg. Co.

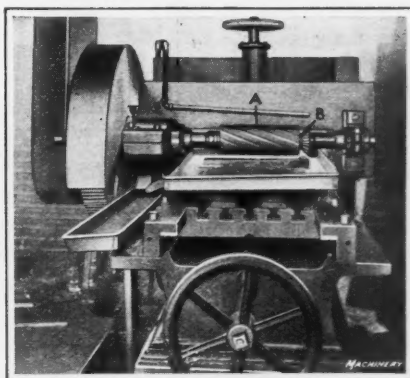
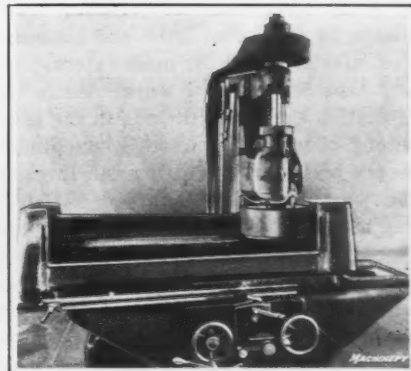


Fig. 3. Milling Gib Keys on Special Machines equipped with Cutters that complete Work at a Single Operation

Fig. 4. Pratt & Whitney Surface Grinder with Magnetic Chuck set at an Angle to grind Taper of $\frac{1}{8}$ Inch per Foot

GENERAL THREAD CUTTING PRACTICE IN THE LATHE¹

IMPORTANT POINTS ON CUTTING SINGLE, MULTIPLE AND TAPERING THREADS BY MEANS OF SINGLE-POINT TOOLS AND CHASERS

BY FRANKLIN D. JONES²

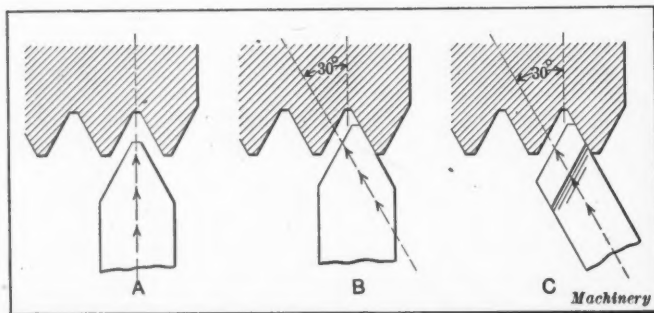


Fig. 1. Straight and Angular Methods of feeding Tool when cutting Thread in Lathe

WHILE the use of the engine lathe for cutting screw threads is very common, a review of some of the more important features of thread-cutting practice will be presented even at the risk of covering ground that is not new to many interested in this general subject. One advantage of the engine lathe as a means of cutting screw threads is that it is adapted for a wide range of pitches and diameters. The swing of the lathe either over the bed or carriage equals, approximately, the maximum diameter of external screw thread that can be cut, and the number of pitches varies according to the change-gear mechanism, but is usually large enough for all ordinary requirements. There is also an advantage in most instances in being able to cut threads on the same machine that is used for the turning operation, because the thread is then cut concentric with other finished surfaces. A well-constructed lathe is also capable of very accurate thread cutting.

Conditions Governing Use of Engine Lathe for Screw Cutting

The conditions under which the lathe is commonly used for cutting screw threads are as follows:

1. When a part has been turned and one or more screw threads must be cut to complete it.
2. When the screw thread is not standard or is so large in diameter that the use of a tap or die is not practicable.
3. When there is not enough thread cutting to warrant the use of machines or equipment designed primarily for screw cutting.
4. When the lathe is the only means available, in which case it is sometimes applied to screw-cutting operations which could be done more efficiently in some other way.
5. When the lathe is the only machine available that will cut threads of the required standard of accuracy.

The engine lathe equipped with a single-point tool is almost invariably used for cutting screw threads on parts that are turned in it, but it is seldom used for threading operations on parts that have been previously turned in another type of machine; in fact, when threading operations are preceded by turning operations, the former are, as a rule, performed in the machine that did the turning, whether it is an engine lathe or some other form of lathe or turning machine. For instance, in the turret lathe and automatic screw machine practice, dies are used for most external thread-cutting operations and taps for internal work. As is quite evident, the object of cutting the screw threads in the same machine is to avoid a second operation on another machine, and, at the same time, secure accuracy by cutting the threads before the position of the work has been disturbed. If, for example, a piston-rod has been turned in the engine lathe and a screw thread is required at the piston end for receiving a nut, the lathe, would, of course, be used for cutting that thread. On the other hand, when cutting a screw thread is the principal operation, the engine lathe may either have competitors or be out of the race entirely. If the part is simply a screw and the only opera-

tion is that of cutting the screw thread, a special threading machine of the die class or a thread milling machine might be used in preference to the lathe. If a thread-milling machine or dye type of thread-cutting machine were not at hand, the lathe would generally be used, unless the number of parts to be threaded were large enough to warrant installing a machine designed especially for screw cutting.

Position of Tool and Traversing Movement

The cutting end of a single-point thread tool is shaped to correspond to the cross-sectional shape of the thread groove in a plane intersecting the axis of the screw. The tool should be so located with reference to the part to be threaded that the angle of the thread cut by the tool will be the same as the tool angle and so that the sides of the thread will incline equally with reference to the axis of the screw. To secure the correct thread angle (assuming that the tool is properly ground), the upper face must lie in a plane coinciding with the axis of the screw; in other words, if the upper face were flat and horizontal it should be at the same height as the lathe centers. A common method of setting a tool so that each side will have the same inclination is by using the gage intended for testing the tool when grinding it. This gage (one form of which is shown at A, Fig. 6) is simply placed against the turned surface to be threaded, in case the thread is straight or cylindrical, and the tool is adjusted until the cutting point fits accurately into the V-shaped notch in the gage. The center line of the tool or a line bisecting the cutting end should be at right angles to the axis of the screw, regardless of whether the screw is straight or tapering, although this practice is varied in the case of a Whitworth thread. This point will be considered later.

In order to form a complete thread with a single-point tool, a number of cuts are required, the number depending upon the pitch of the thread and the corresponding depth of the thread groove. On all standard engine lathes, a gear-driven lead-screw is used to traverse the tool a distance equal to the lead of the thread for each revolution of the part being threaded. Gearing of the correct ratio may be placed in position each time a screw thread of different lead or pitch is to be cut, or the gearing may form an integral part of the machine, and be so arranged that the necessary combination can be engaged by simply shifting the controlling handles or levers. The calculation of change-gears and the adjustment of lathes for cutting threads of different pitches have been covered in so many technical books and periodicals that this part of the general subject will not be considered here.

Straight and Angular Methods of Feeding Tool Inward

The inward feeding movement of a tool for each successive cut may be either at right angles to the axis of the screw

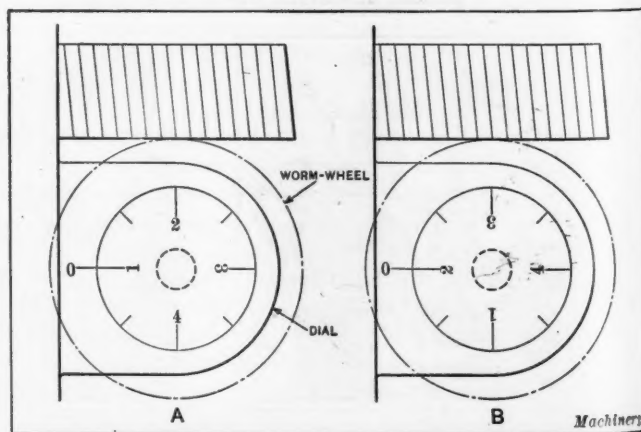


Fig. 2. Diagrams illustrating Arrangement of Thread Chasing Dial or Indicator

¹For information on thread cutting previously published, see "Thread-cutting Attachments," in the February number of MACHINERY, and articles there referred to.

²Associate Editor of MACHINERY

thread, as indicated at A, Fig. 1, or at an angle of 30 degrees as shown at B. With the latter method the compound rest is set at an angle of 30 degrees. If the lathe is not equipped with a compound rest, the feeding movement must be, of course, as shown at A. The objection to this method is that the cutting action is not so good as when one edge of the tool does practically all the cutting, as at B, and the other edge moves parallel to the opposite side of the thread. The angular method of feeding the tool does not tend to tear the thread as when the tool is fed straight in, and a smoother thread is cut. After most of the metal has been removed by the angular feeding method, the tool may be moved straight in to take a light finishing cut.

The thread tool illustrated at C is intended especially for feeding in at an angle. This tool is given top rake and all the cutting is done on one side. As the illustration shows the compound rest is set at an angle of 30 degrees for cutting 60-degree threads such as the U. S. standard or sharp V-threads. The point of the tool forms one side of the thread as it feeds in at this angle and the cutting edge forms the opposite side. This form of tool cuts easily, because of the top rake or slope, and it is particularly adapted for coarse threading operations. Sometimes an ordinary thread tool is used for taking a light finishing cut after roughing out the thread by a tool of the type referred to.

Return of Tool for Successive Cuts

There are two ways of returning the lathe carriage and tool to the starting point for taking another cut after one or more cuts have been completed. One method is by disengaging the carriage from the lead-screw and returning it by hand; the other is by allowing the carriage to remain in engagement with the lead-screw and reversing the lathe or lead-screw at the completion of each cut. If the number of threads per inch on the screw being cut is a multiple of the number per

inch on the lead-screw, the carriage may be disengaged and re-engaged with the lead-screw at random and the tool will always follow the original or first thread groove that was cut; when the number, however, is not a multiple of the number on the lead-screw, the tool may not engage the thread groove properly. When it is necessary to adopt some method of keeping the tool in the right relation to the work, if the screw is quite short the carriage may remain in engagement with the lead-screw until the thread is finished, but for cutting comparatively long screw threads this method of returning the carriage would require too much time and it can be returned more quickly by hand. When lathes have exposed change-gears, marks are sometimes made on the gears to insure re-engaging the carriage lock-nut with the lead-screw at the right time; most of the modern lathes, however, are equipped with an indicator or thread chasing dial for "catching the threads."

Principle of Engine Lathe Chasing Dial or Thread Indicator

The thread chasing dial of an engine lathe is attached to the carriage and has a worm-wheel (see Fig. 2) that meshes with the lead-screw. The vertical spindle or shaft of this worm-wheel carries a graduated dial which shows when to re-engage the carriage with the lead-screw when cutting screw threads which are not a multiple of the number per inch on the lead-screw. The number of teeth in the worm-wheel of the indicator should be a multiple of the number of threads per inch on the lead-screw, and the number of main divisions on the dial should equal the number of teeth on the worm-wheel divided by the number of threads per inch on the lead-screw. Each main division will then represent an inch of carriage

travel. For instance, if the lead-screw has six threads per inch and the worm-wheel twenty-four teeth, then there should be 24 — = 4 main divisions or graduations on the dial. We shall assume that 11 threads per inch are being cut and that the carriage was engaged with the lead-screw when graduation line No. 1 was opposite the zero line on a stationary part of the indicator as illustrated at A. If the tool were withdrawn from the thread groove and moved back a distance equal to one-sixth inch, or one lead-screw thread, it would not be opposite a thread groove on the work; the same would be true for a backward movement equal to two, three, four, or five threads on the lead-screw, but a movement of six lead-screw threads, or one inch (as indicated by B) would bring the tool in line with a thread groove eleven threads away from the point of disengagement; therefore, by always re-engaging the carriage with the lead-screw when one of the graduations representing an inch of travel is in line with the zero mark, the tool will follow the original cut. If in the preceding example the number of threads per inch being cut were ten instead of eleven, or any other even number, a half inch of backward movement would have located the tool directly opposite a thread groove; hence, if the four main divisions on the indicator dial previously referred to were subdivided, making eight divisions in all, any of these half divisions could also be used for "catching the thread" when cutting an even number of threads per inch. If 11½ threads per inch were being cut, those graduations on the dial representing a movement equivalent to two inches or twenty-three threads on the work would be used when re-engaging the carriage and lead-screw. For instance, suppose there are four main divisions on the dial, each representing one inch of carriage travel and numbered 1, 2, 3, and 4

as shown; then if engagement were made for the first cut when, say, line No. 1 was opposite the zero mark, either this line or line No. 3, two divisions from it, would indicate the point of engagement for succeeding cuts. Some indicator dials have a circle of graduations for even numbers of threads per inch, representing a half-inch carriage travel; another circle of graduations for odd numbers representing inches of carriage travel; and a third circle for fractional pitches (like 11½ threads per inch) representing two inches of carriage travel.

Cutting Multiple Screw Threads

When cutting multiple screw threads, the general method of procedure is about the same as for single screw threads except that the lathe must be geared according to the number of single threads per inch, or with reference to the *lead* of the thread, not the pitch, and provision must be made for locating the tool when cutting the different thread grooves. The tool may be located (1) by indexing or turning the piece being threaded a fractional part of a revolution; (2) by setting the compound slide parallel with the screw thread being cut so that the slide can be used for adjusting the tool; (3) by disengaging the lock-nut from the lead-screw while the lathe spindle is stationary, moving the carriage the required distance; (4) by engaging the lead-screw at the proper time (with the lathe in motion), as shown by graduations on the thread chasing dial or indicator.

Indexing for Multiple Thread Cutting

When the screw is indexed for locating the tool in connection with thread-cutting, it is given one-half turn for a double thread, one-third turn for a triple thread, one-fourth turn

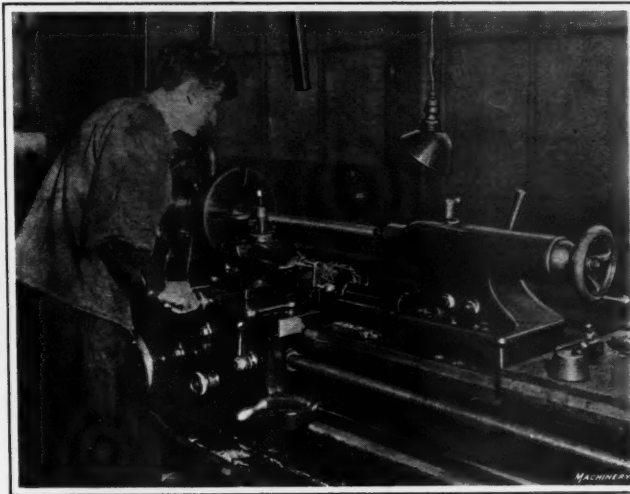


Fig. 3. Compound Rest set Parallel to Axis of Screw for adjusting Tool when cutting Multiple Thread

for a quadruple thread, and so on. An easy method of indexing for a double thread when the work is held between centers is simply to remove the parts from the lathe and turn it one-half revolution by placing the driving end of the dog in the opposite slot of the faceplate. The objection to this method is that any error in the location of the faceplate slot would be reproduced in the screw thread. Another common method (when using the change-gear type of lathe) is to disengage the stud gear and idler gear after marking whatever tooth happens to be in mesh, and then turn the spindle half a revolution for a double thread, one-third revolution for a triple thread, etc. If the ratio of the gearing between the stud and

far enough for the tool to clear the end of the work before starting another cut; for instance, if the tool were 10 inches from the starting end and a double thread having a one-inch lead were being cut, the carriage should be moved at least $10\frac{1}{2}$ inches. This adjustment could also be obtained in this particular case, if the lead-screw had an even number of threads per inch, by moving the carriage and tool one-half inch (pitch of thread) and then, after re-engaging the lock-nut, turning the lathe backward to secure the necessary additional movement.

Whether or not the lock-nut can be re-engaged with the lead-screw after shifting the carriage a given distance may be determined as follows: If the carriage is moved a whole or even number of inches (not fractional), the lock-nut can, of course, be re-engaged with any lead-screw having a whole number of threads per inch. If the number representing the carriage adjustment is fractional, the number of threads per inch on the lead-screw must be divisible by the denominator of the fraction.

Use of Thread Indicator for Multiple Thread Cutting

The thread chasing dial or indicator may sometimes be used to advantage for engaging the tool with the different multiple thread grooves when cutting a screw thread of this kind. By means of the indicator, the engagement of the lock-nut with the lead-screw is so timed that the tool, after taking a cut through one thread groove will be in position to cut the other groove or grooves, as the case may be, before feeding the tool inward, instead of finishing one groove at a time. To illustrate, suppose a double-threaded screw is to be cut having a lead of $\frac{1}{2}$ inch ($\frac{1}{4}$ inch pitch) or two single threads per inch. We shall assume that the lead-screw of the lathe has 4 threads per inch, the indicator worm-wheel 24 teeth, and the dial 6 main divisions, representing inches of carriage travel, and 6 subdivisions representing half inches of carriage travel. Since the number of threads per inch is even in this case, the lock-nut may be engaged with the lead-screw when any division line on the dial is opposite the zero mark, and the tool will follow the original cut. After taking a cut in one thread groove and moving the carriage back to the starting point, the lock-nuts are next engaged when the zero line is midway between any two lines on the dial; the tool will then cut another groove midway between the first one, or a distance from it equal to the pitch of the thread. If there were an odd number of single threads per inch, say, three, engagement would be made on any main division line for cutting one groove of a double thread, and on any subdivision for the other groove.

Multiple Tool for Cutting Multiple Threads

The different thread grooves of a multiple screw thread may be cut at the same time by using a tool for each groove,

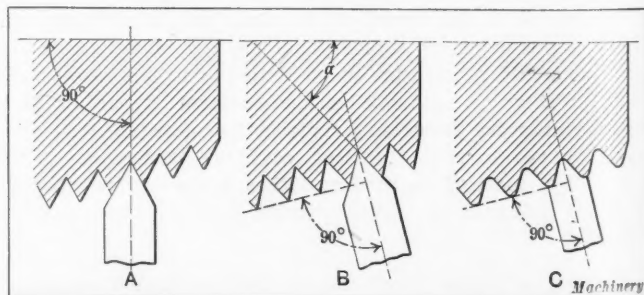


Fig. 5. Correct and Incorrect Positions of Tool for Taper Thread Cutting. The tools being spaced according to the pitch of the thread. The Dale multiple-tool holder is shown in Fig. 4. This particular holder is arranged for cutting square threads, although the same general type may be applied to other forms. The main part of the holder A is channeled or grooved to receive the cutting blades or tools. The space between these tools is regulated by the distance piece B, and they are held at an angle by tapering strips C (see end view). This inclination varies, of course, with the pitch and diameter of the screw thread. The tools and strips B and C are held in position by set-screws D. The tapering part E above the tools provides a

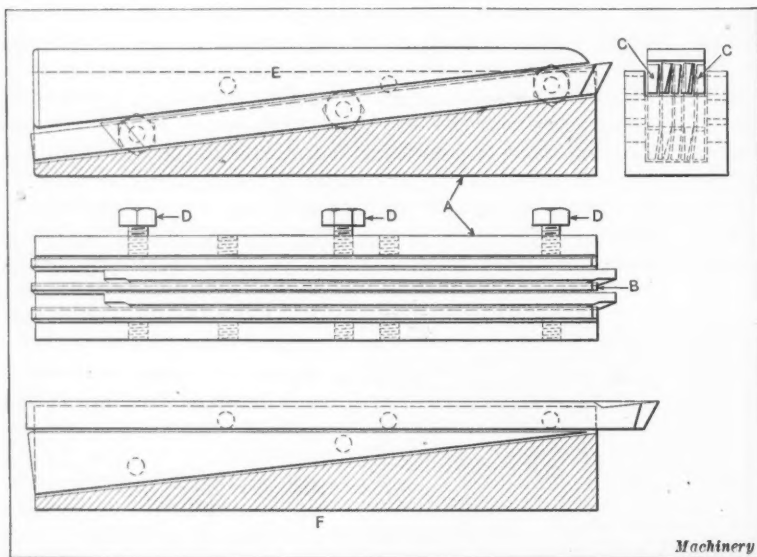


Fig. 4. Multiple Tool for cutting Both Grooves of Double Thread simultaneously

the spindle were other than 1 to 1, this would affect the indexing movement; moreover, in order to apply this method the number of teeth in the stud gear must be evenly divisible by 2 for a double thread, 3 for a triple thread, and so on. A convenient method of indexing multiple-threaded screws is by means of a special faceplate formed of two parts, one of which is free to rotate after loosening the clamping bolt. Graduations on the edge or periphery of one plate are used for turning the adjustable section the required amount.

Use of Compound Rest for Adjusting Tool when Cutting Multiple Threads

When a lathe has a compound rest, this may be used for adjusting the tool when cutting the different thread grooves of a multiple screw thread. The compound rest is set parallel to the axis of the screw, as shown in Fig. 3, and after one thread groove is cut, the tool is moved a distance equal to the pitch of the thread or one-half the lead for a double thread, one-third the lead for a triple thread, etc. When the feed-screw has a graduated dial, this adjustment of the tool can easily be made. The compound rest method is very convenient and has the advantage over the use of a special faceplate that parts may be held in the chuck for internal threading operations. The accuracy of the tool adjustment and of the screw that is cut depends upon the accuracy of the feed-screw of the compound rest slide; ordinarily, the errors from this source would be so small as to be negligible.

Adjusting Tool for Multiple Thread Cutting by Shifting Carriage

When a tool is located for cutting different thread grooves of a multiple screw thread by shifting the carriage and tool, the adjustment must be such that when the tool is in the correct position, the lock-nut may be re-engaged with the lead-screw. If a double thread is being cut having a lead of, say, one inch the tool could be located for cutting the second thread groove by disengaging the lock-nut (with the lathe spindle stationary) and moving the carriage back a distance equal to the pitch of the thread, or one-half inch. If the adjustment were equal to the pitch plus the lead or the pitch plus any multiple of the lead, the tool would still be in position for cutting the second thread groove. In actually cutting a screw thread, it would, of course, be necessary to move the carriage

horizontal surface for clamping the tools in position in the tool-holder. When this holder is used for cutting Acme or other screw threads of angular form, the tools are held in a horizontal position by inserting a tapering piece beneath them as shown at *F*. A flat plate is then applied to the top to form a bearing surface for the tool-holder clamping screw. The blades used in this holder are of the same section throughout their length to provide for repeated grinding.

Position of Tool for Cutting Taper Screw Threads

It is the general practice in this country to set a tool for cutting tapered screw threads as shown at *A*, Fig. 5, or so

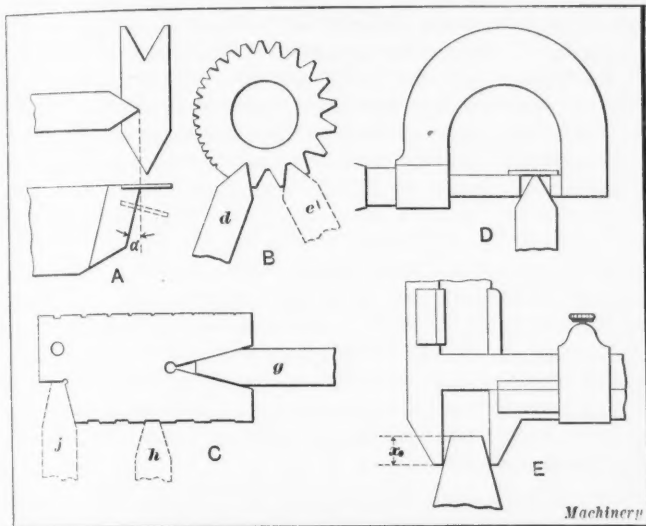


Fig. 6. Methods of gaging Thread-cutting Tools

that the sides of the thread incline equally with reference to a line perpendicular to the axis of the screw. The principal reason why taper threads should be cut with the tool in this position is that taper taps are made in this way or with the threads normal to the axis. If the tool were set in the position shown at *B* or so that the sides of the thread incline equally with reference to the tapering surface, obviously such a thread would be a poor fit in a hole tapped with an ordinary taper tap having threads normal to the axis as at *A*. If the hole and the tapering part which screws into it were both threaded normal to the surface as at *B*, the thread would be satisfactory unless there were an unusual amount of taper. In extreme cases, angle α (see diagram *B*) of one side of the thread might be so small that the radial or bursting pressure on the nut would be excessive owing to the wedging action. It is the practice to cut Whitworth pipe threads and most other Whitworth threads which are tapering, with a tool set perpendicular to the side of the tapering surface as shown at *C*, because the same tools that are used for parallel threads can then be used for taper threads. If a tool used for parallel thread cutting were set at right angles to the axis, one side of the crest of the thread would not be cut to a circular form if the tool were of the shape illustrated, because the curved cutting edges would be the same distance from the axis of the screw and only one side of the circular part of the tool would cut. This difficulty is not encountered with the thread forms like the U. S. standard or V-threads.

The top cutting face of the tool should lie in a horizontal plane coinciding with the axis of the work for all taper thread cutting. It is much more important to have the tool at the same height as the lathe centers when cutting taper threads than when cutting parallel threads for the reason that a section parallel to the axis of a cone is not straight but curved; consequently, not only is the angle of the thread changed but a curved tapering thread also is produced.

Adjustment of Lathe for Taper Thread Cutting

An engine lathe equipped with a taper attachment should be used for taper thread cutting if possible. When the required taper is obtained by setting the tailstock off center, the thread will not advance at a uniform rate or form a true helix, especially when an ordinary bent-tail driving dog is used. This "drunken thread" or error is caused by the angularity

between the driving dog and the faceplate, which causes the rotating speed of the work to vary during each revolution. The bearing surface between the lathe centers and the work-centers when the tailstock is offset is another cause of inaccuracy, because as the work-centers wear rapidly on account of the poor bearing surface, the angle of the taper is changed as the tailstock spindle is tightened. The amount of these errors depends upon the angle of the taper and the distance that the centers must be offset. When a plain (not threaded) gage of the required taper is available this may be used for adjusting the taper attachment accurately prior to the thread-cutting operation. The taper gage is placed between the centers (which should be in line) and a dial indicator is fastened in the tool-holder. The carriage is then traversed while the indicator is in contact with the taper gage, and the taper attachment is adjusted until the hand of the indicator remains practically stationary as it is traversed from one end of the gage to the other. This method has been employed in making thread gages of the plug form. Many tapering threads, especially when large numbers of duplicate parts are required, are cut by means of chasers or special dies.

Internal Thread-cutting Operations

The general methods of cutting internal threads in the engine lathe are: (1) by means of a single-point tool; (2) by using a tap supported by the tailstock spindle; (3) by using a single-point tool followed by a tap; (4) by using a multiple-point tool of the chaser class. The single-point tool is used for most internal thread-cutting operations. If the hole to be threaded is quite small in diameter, it is difficult to cut an accurate thread with a single-point tool, especially if the hole is quite long or deep, because of the flexibility of a tool small enough to enter the hole. On work of this kind a tap may be used or the thread is sometimes cut slightly under size with a single-point tool, and a tap having its shank or outer end held straight by the tailstock center is run through the hole for taking a light finishing cut.

Gaging Single-point Thread Tools

The accuracy of a screw thread cut in a lathe may be affected as to pitch or lead by the lead-screw, and as to the angle or form of thread by the tool used for the thread-cutting operation or its position when in use. For ordinary work the tool is ground either by hand or, preferably, by the use of a

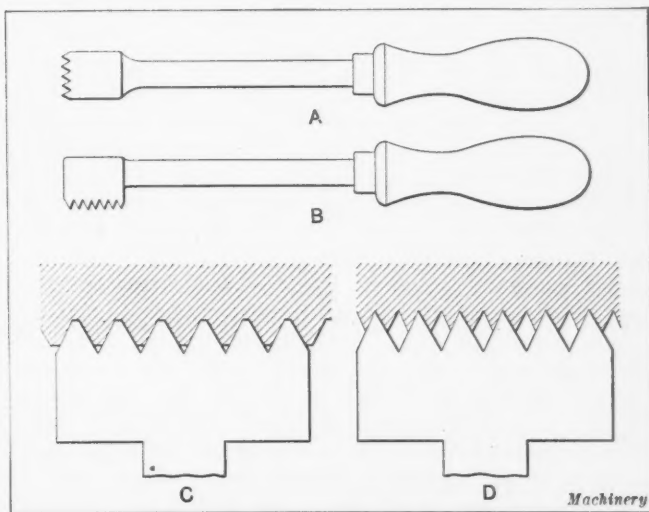


Fig. 7. Hand Chasers—Threading Tool Chasers

special tool grinder of the type used for sharpening turning and planing tools. When the angle of the cutting edge is being tested by a gage, the latter should be held in the same plane as the cutting edge, as at *A*, Fig. 6, and not at right angles to the front side, as shown by the dotted lines, assuming that the notch in the gage conforms to the standard thread angle. If the clearance angle α of a tool is 15 degrees, the angle in a plane at right angles to the front face is about 61 degrees 45 minutes, when the angle in the plane of the cutting edge is 60 degrees; hence, if the tool were ground to fit a gage held as shown by the dotted lines at *A*, the angle of the cut-

WIDTHS OF ENDS OF TOOLS FOR CUTTING SQUARE THREADS

Number of Threads per Inch	Width of End of Tool		
	For Taps	For Screws	For Internal Threads
2	0.2475	0.2500	0.2525
2½	0.1975	0.2000	0.2025
3	0.1641	0.1666	0.1691
3½	0.1408	0.1428	0.1448
4	0.1235	0.1250	0.1265
4½	0.1096	0.1111	0.1126
5	0.0985	0.1000	0.1015
5½	0.0894	0.0909	0.0924
6	0.0818	0.0833	0.0848
7	0.0699	0.0714	0.0729
8	0.0615	0.0625	0.0635
9	0.0545	0.0555	0.0565
10	0.0490	0.0500	0.0510
11	0.0444	0.0454	0.0464
12	0.0407	0.0417	0.0427
13	0.0375	0.0385	0.0395
14	0.0352	0.0357	0.0362

Machinery

ting edge would be too small. At *B* is shown a simple form of gage for testing U. S. standard thread-cutting tools. These tools have a flat end or edge equal in width to one-eighth the pitch of the thread. This particular gage has notches marked for different pitches. The tool is first ground to a 60-degree angle, the V-shaped notch in the gage being used as shown at *d*. The point is then ground off to the right width or until the tool fits into a notch corresponding to the required pitch, as illustrated at *e*.

An Acme thread gage is shown at *C*. This gage also has notches for different pitches. The 29-degree notch at the end of the gage is used first for testing the angular sides of the tool when grinding as at *g*. The shallow notches are used simply for testing the width of the cutting edge at the end as at *h*, the numbers opposite the notches representing the number of threads per inch. The angle between the side and the end may be tested as illustrated at *j*. The tool may also be set square with the work by placing one edge of the gage against the turned surface and adjusting the tool until it coincides with the gage, as indicated by the dotted lines at *j*. The width of an Acme thread tool equals $0.3707 \times \text{pitch} - 0.0052$.

Testing Width of Flat End of U. S. Standard and Acme Thread Tools

The width of the flat or end of either a U. S. standard or Acme thread tool may be measured by using an ordinary micrometer as illustrated at *D*. In measuring the tool, a scale is held against the spindle and anvil of the micrometer and the end of the tool is placed against this scale. The micrometer is then adjusted to the position shown, and for a U. S. standard thread tool 0.2887 inch is subtracted from the reading; the result equals the width of the tool point which should equal one-eighth the pitch. For an Acme thread tool 0.1293 inch is subtracted from the micrometer reading to obtain the width of the tool point. The constants (0.2887 and 0.1293) which are subtracted from the micrometer reading are only correct when the micrometer spindle has the usual diameter of 0.25 inch. The value or constant for any other spindle diameter could be obtained by multiplying twice the spindle diameter by the tangent of one-half the thread tool angle.

An ordinary gear tooth caliper may also be used for testing the width of a thread tool point, as illustrated at *E*. If the measurement is made at a vertical distance x of $\frac{1}{4}$ inch from the points of the caliper jaws, the values previously given for U. S. standard and Acme threads should be subtracted from the caliper reading to obtain the actual width of the cutting end of the tool.

When a tool for cutting a U. S. standard thread is accurate as to the angle and width of point or flat, an accurate screw may easily be cut by the following method: First turn (or grind) the screw blank to the outside diameter of the screw within whatever limits of accuracy are considered necessary. Before starting the thread-cutting operation, adjust the tool in-

ward until its front edge just touches the surface of the blank, and then feed the tool inward for taking successive cuts until it has moved a distance equal to 0.6495 times the pitch of the thread. If the cross-feed screw does not have a micrometer dial for measuring the movement of the tool, it is a comparatively simple matter to gage the movement of the tool-slide by attaching a pin or block to it and measuring from a fixed pin or block. In the case of an Acme thread, the inward movement of the tool should equal one-half the pitch of the thread plus 0.010 inch.

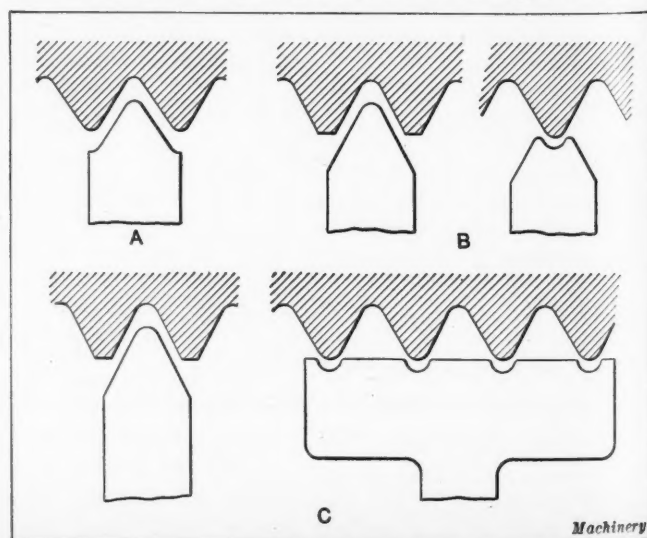
Width of Tool Point for Cutting Square Threads

In order to provide clearance between the threads of a square-threaded screw and nut, the width of the thread groove in the nut is made somewhat greater than one-half the pitch of the thread. The width of the point of the tool for cutting external screws with square threads should be exactly one-half the pitch, but the width of a tool for cutting internal threads or the threads on taps which are afterward to be used for tapping nuts, should be slightly less than one-half the pitch so that the cutting teeth are a little wider than the theoretical standard width. The thread groove cut in the nut will then be slightly wider than the thread on the screw, thus providing the necessary clearance. An inside threading tool for threading nuts evidently should be of the same width as the teeth on the tap, or slightly wider than one-half the pitch. The widths of the points of tools for all ordinary pitches from 2 to 14 threads per inch are given in the accompanying table, which includes tools for threading taps, cutting screws and cutting the threads in nuts.

Use of Thread Chasers in the Lathe

A chaser is a form of threading tool having a number of teeth instead of a single point like the threading tools commonly used for screw-cutting in the engine lathe, although the term "thread chasing" is often used to indicate the cutting of a thread with a single-point tool. The two general classes of chasers (exclusive of those used in dies) are hand chasers and threading tool chasers. The former are hand-controlled, and the latter are rigidly held in a tool-holder and used like an ordinary lathe threading tool. Two types of hand chasers are shown at *A* and *B* in Fig. 7. Form *A* is used for chasing external threads and form *B* for internal threads. When the tool is in use, the cutting end is supported by some form of rest held in the toolpost. These hand chasers are convenient for truing up battered threads or for reducing the size of a part which has been threaded by either a die or a single-point tool. Tools of this kind are especially adapted for brass work. The chaser used in any case has teeth spaced to correspond to the pitch of the thread. This form of tool can be applied to the work quickly and without gearing the lathe for a thread-cutting operation.

Threading tool chasers which are held rigidly in the tool-holder are used practically the same as a single-point tool, the lathe being geared for traversing the tool along the work in



Machinery

Fig. 8. Different Forms of Tools for cutting Whitworth Threads

order to control the lead of the thread. Tools of this kind cut threads rapidly and may be used for roughing out threads preparatory to finishing them with a regular single-point tool. Many screw threads are also finished completely with chasers of this type, although they are not adapted for extremely accurate work unless the teeth are ground after hardening because the pitch of the chaser teeth is affected more or less by the hardening operation. A threading tool chaser for a U. S. standard thread is shown at *C*. The spaces between the teeth extend to a sharp vee instead of having flats the same as the cutting ends, in order to provide clearance for the top of the thread.

The pitch of the chaser teeth does not always equal the pitch of the thread to be cut. For instance, the chaser illustrated at *D* has a pitch double that of the screw thread. Every alternate groove is engaged but as the lathe is geared for the pitch of thread to be cut, each tooth of the chaser follows the thread groove the same as though it were a single tool. Chasers are sometimes made as shown at *D* for cutting very fine threads, because in this way larger and stronger teeth are obtained.

Tools for Cutting Whitworth Threads

The Whitworth form of thread, or the British standard, may be cut by using a single tool of the form illustrated at *A*, Fig. 8. This tool is so shaped that it finishes the rounded crest of the thread as well as the angular sides and the root. As this tool is rather difficult to make, many Whitworth threads, especially in jobbing and repair shops, are cut by using two tools as illustrated at *B*. One finishes the angular sides and the root, whereas the other is used for finishing the crest of the thread as the illustration shows. In English machine shops, threads of ordinary pitches are often cut as indicated at *C*. After the angular sides and root of the thread have been finished by a tool having a rounded point, the crest of the thread is rounded off by using a hand chaser. The radius of both the crest and the root of a Whitworth thread equal 0.1373 times the pitch, and the depth of the thread equals 0.6403 times the pitch. The angle between the sides as measured in an axial plane is 55 degrees.

Automatic Threading Lathe

The automatic threading lathe built by the Automatic Machine Co., Bridgeport, Conn., is especially adapted for threading duplicate parts in quantity, because the movements of the lathe are automatically controlled after the work is placed in position and the lathe is started. As the forward and return movements of the carriage and the movements of the tool are controlled mechanically, the machine operates more rapidly and continuously than an ordinary engine lathe. A detail view of the machine and the work is shown in Fig. 9. The head-stock is of the geared type, and is arranged for varying the forward cutting speed and for reversing the rotation of the spindle, the latter being effected automatically at the completion of the cut. The carriage has front and rear tools and, when the machine is in operation, these tools are fed in automatically to the required depth; the carriage is then traversed along the bed by a central lead-screw, and when the tools reach the end of the cut, they are automatically withdrawn and the carriage is returned to the starting point. The tools are then fed in again far enough for taking a new cut, and the cycle of operations is repeated until the thread is finished to the size for which the machine is set, when the feeding of the tools is automatically stopped. As shown, there are four positions or holders for the cutting tools. For external work two tools are used, one being at the front and the other at the rear as previously mentioned. When cutting a thread close to a left-hand shoulder, the two left-hand positions or holders are utilized and if the shoulder is on the opposite side the two right-hand holders are employed.

By using two cutting tools for external work, it is possible to have one tool cut one wall or side of the thread, while the other tool operates on the opposite side of the thread. When the tools are applied in this way, they may be ground with top rake in order to secure a better cutting action. When cutting an angular thread, such as the Acme or a worm thread, a square-nosed roughing tool is sometimes used in the

rear and a form-finishing tool in the front. A finishing tool of the gooseneck or spring type is recommended. Another method of cutting a thread of similar form is to mount a single square-nosed roughing tool in advance of the front and rear tools. The square-nosed tool then cuts a rough groove which is finished by the two following tools, taking shearing cuts on opposite sides of the thread. When cutting a square thread, a roughing tool, which is about 0.02 inch narrow, is used, and the thread is finished to the required size by a tool in front. When cutting a double thread, both thread grooves may be cut simultaneously by using four tools; two parallel roughing tools operating in adjacent grooves are located at the rear, and two finishing tools at the front of the machine. For internal threading, the tool-holder may be provided with a roughing cutter followed by a finishing cutter. Cutters of the circular form type are used ordinarily. Change-gears are employed for adapting the machine to cut threads of different pitch.

One of the important features of this lathe is the back-shaft which controls the traversing movement of the carriage and the points of reversal, as well as the inward and outward movements of the cutting tools. When the carriage reaches the end of its travel at the completion of the cut, it comes against an adjustable collar on the back-shaft. The result is

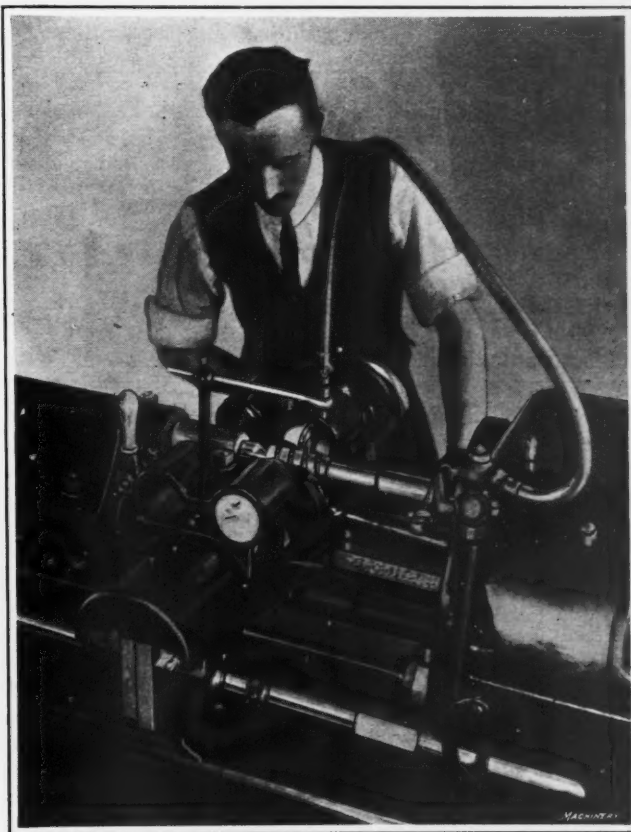


Fig. 9. Automatic Threading Lathe cutting Screw Thread

that the back-shaft is shifted longitudinally, and this endwise motion throws into engagement a mechanism at the head-stock end of the machine, which causes the back-shaft to revolve one-half revolution. This rotation serves a double purpose in that it withdraws the two cutting tools from the work, and, at the same time reverses the motion of the lathe spindle. When the carriage reaches the end of the return movement, caused by the reversal of the spindle and lead-screw rotation, it encounters another stop on the back-shaft, so that the latter is again shifted in the opposite direction. This endwise movement again causes the back-shaft to revolve one-half revolution, which automatically moves the tools inward for the next cutting stroke. The tools are moved a little farther inward for successive strokes by a ratchet and pawl mechanism.

* * *

The War Department has announced that hereafter the metric system of measurement will be employed as the standard for all artillery, machine guns, and maps used by the American Overseas Forces.

WASTING NATURAL RESOURCES

Attention is called in *The Little Journal*, published by Arthur D. Little, Inc., of Cambridge, Mass., to the enormous loss to the nation due to waste of natural resources. If coal ran over Niagara Falls only to feed a great bonfire at the base, we should all be shocked, but the present loss is just as great as if that were so. Half a million or more horsepower easily available at Niagara runs to waste; meanwhile the lights are turned out on our streets to save a few tons of coal. If the water of Niagara (equivalent to from 5,000,000 to 7,500,000 tons of coal annually) was used for power and once a month the water was allowed to flow over the Falls for a day, there would still be a scenic Niagara, and probably more people would actually visit it than at the present time.

Through lack of supervision, a billion cubic feet of natural gas has been permitted to go to waste daily for long periods. Through lack of proper regulation, 500,000,000 tons of coal have been wasted at the mines annually. Three tons of phosphate rock are wasted to one that is used, and only 50 per cent of the zinc mined reaches the market as spelter. Sulphate pulp liquids still pollute the streams, while a wealth of alcohol, gas, and fuel might be recovered from them. Potash is wanted at \$450 a ton, but most of the cement mills waste it. Flax straw may be made into the finest quality of writing paper, but it is burned in the fields; so are also most cereal straws, which may be briquetted into excellent fuel, or baled and used for gas making. If we used all the materials that nature provides, instead of attempting to get rid of them in the easiest and most convenient manner, we would probably be able to pay for the war out of waste products and still have something to spare.

Buy War Savings Stamps. If you want to be a fighter behind the lines in the war for democracy, save your quarters and invest them in Thrift Stamps. Many of us cannot go into the trenches, some of us cannot buy Liberty Bonds, but everyone can buy War Savings Stamps. If you want to do more than your "bit," help to establish War Savings Societies and induce others to do their share in achieving victory. There are only two requirements—ten or more members and the promise to save. There is a place for a War Savings Society in every business office and factory. The spirit to take part in the great war is sweeping the country. The War Savings Societies is the answer. For details, inquire at any post-office.

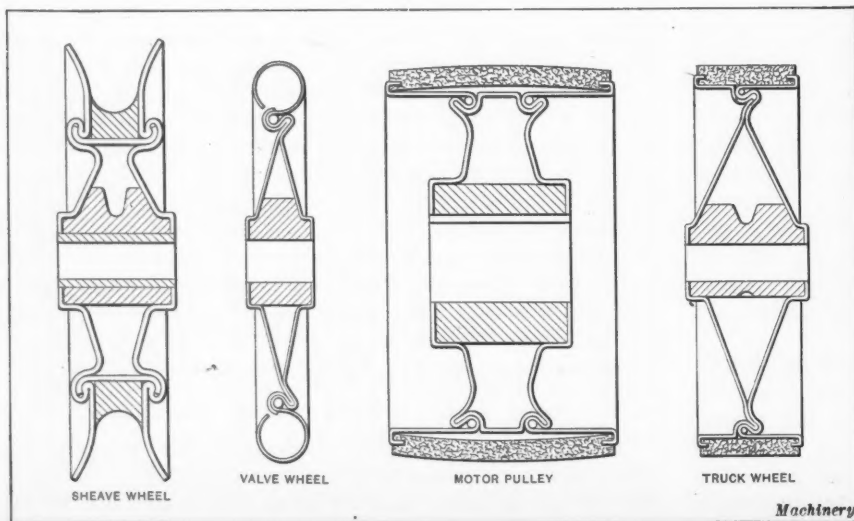


Fig. 3. Other Designs of Interlocking Sheet-metal Wheels

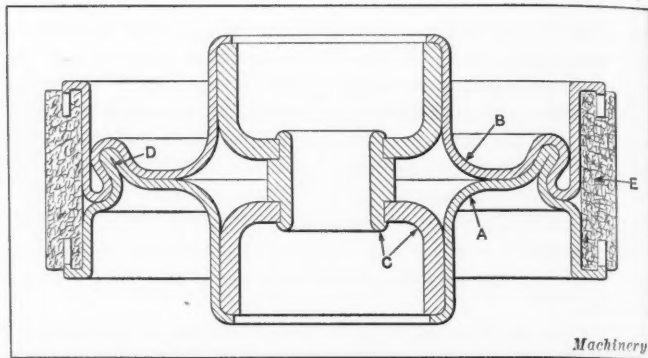


Fig. 1. Sectional View of Zamboni Interlocking Sheet-metal Roller Skate Wheel

ZAMBONI PRESSED-METAL WHEEL

The Zamboni sheet-metal wheel is interesting both as a wheel and as an example of die work. The prominent feature is the interlocking rim which binds one half of the wheel center to the other half and at the same time strengthens the wheel and makes it very rigid. The most important application of this interlocking sheet-metal wheel at the present time is in roller skates. An enlarged sectional view of the skate wheel is illustrated in Fig. 1. It is composed of two main sections

A and B and an inserted hub C, which is designed to receive a double ball bearing. The two sections A and B are locked together by forcing the annular ridge D of one section into a groove formed in the other section. Before these two parts are locked to-

gether, the interlocking ridge and the groove are both parallel with the axis of the wheel. One section is then securely interlocked with the other by means of a die which presses the ridge and groove over to an angle of approximately 45 degrees, as shown. The two main sections of the wheel are drawn up from flat stock. The three-piece hub is formed of two drawn cups connected by a sleeve at the center, which is machined and riveted to each cup.

The sequence of operations for producing the main sections A and B is illustrated in Fig. 2. The order of operations on section B is also illustrated in Fig. 4. The operations on these two parts are practically the same, except that an annular ridge is formed on one and a groove on the other at the point where they interlock. The first operation on section B is performed in an ordinary combination blanking and drawing die, which forms a cup as shown at A in Fig. 4. This cup is next drawn to a greater depth, as illustrated at B, but the diameter remains the same. The third operation is performed in a drawing and forming die, which pushes the top of cup B (obtained from the second-operation die) downward, thus obtaining the shape shown at C. The punch is shaped to fit the inner part a, whereas the seat in the die conforms to the shape of the opposite side. The die is equipped with a knock-out, of course, which bears against the end b. The fourth operation is practically the same as the third, the object being to reduce the diameter and deepen the central part of the wheel center, as illustrated at D. For the third and fourth operations the work is not in the position illustrated in Fig. 4, but is inverted. For the fifth operation, however, the part rests in the die in the position shown at E. This operation is performed by a punch which is in the form of a sleeve.

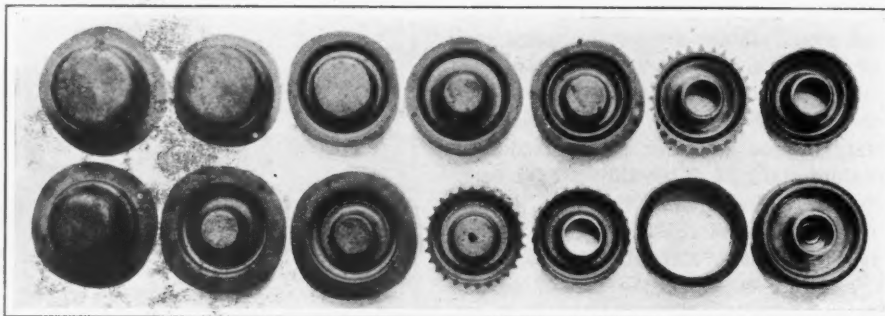


Fig. 2. Various Blanking, Drawing, and Forming Operations on Wheel Sections

The punch fits over the central part *c* and engages the work at *d*. The operation is simply one of pushing down this central part to form a semicircular channel *d* around the base of the central part *c*. The knock-out or ejector is located within the punch. This completes the drawing and forming operations.

The flange of the shell is next blanked out in a die that forms V-shaped teeth around it, as illustrated by the plan view at *F*. Each time a part is blanked, a ring of scrap is pushed up onto the punch, and, in order to remove these scrap rings, there is a double-ended V-shaped knife or blade extending through the punch and projecting far enough at each side to sever the scrap rings. This scrap-cutting blade is located about 3/4 inch above the die, so that the punch is filled with scrap up to this point and the upper scrap ring is cut in two each time a part is blanked and another ring is forced onto the punch. After a hole has been blanked at *f* (see view *G*), the V-shaped teeth are next bent downward, as at *H*, so that they will be parallel to the axis of the wheel. A simple type of bending die is used for this work. The punch used in connection with this die is in the form of a thin sleeve which surrounds the wheel center and fits into the space *e*. The die has a plain hole through it, and the V-shaped teeth are bent by simply pushing the part down through the die. This completes the operations on this part. When the two wheel sections are forced together and interlocked as previously explained, a leather rim *E*, Fig. 1, is placed between them, which is gripped by the V-shaped teeth previously referred to. The reason for using this leather rim in preference to a steel ring is that it is practically noiseless, which is a desirable feature for roller skates, especially when used in skating rinks.

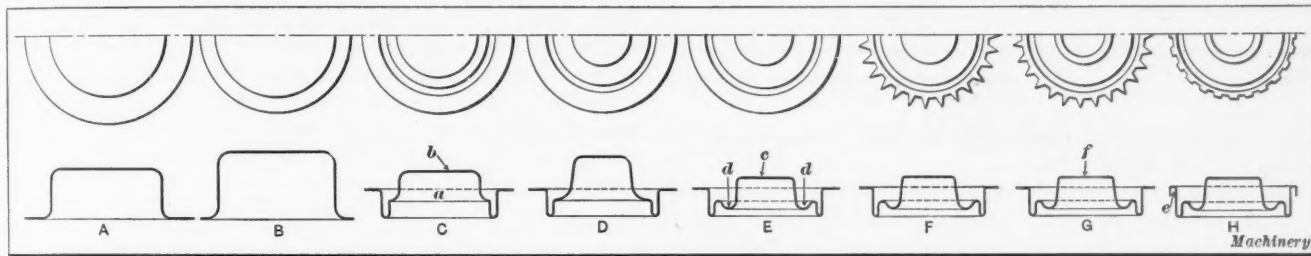


Fig. 4. Order of Operations on One Half of Sheet-steel Wheel Center

The use of this interlocking type of wheel (which is the product of the Apex Steel Corporation, 50 Church St., New York City) is not confined to skate wheels, as the same principle of construction may be applied in making sheave wheels (see Fig. 3), handwheels for valves, belt pulleys for motors, truck wheels, etc., and for many other purposes. The design of the wheel is varied somewhat, depending upon its size and width. Wheels that are comparatively small and narrow are formed of two sections that interlock directly, the same as the skate wheel, but in the case of a belt pulley or sheave of rather large size, the two main sections are connected by an intermediate section.

F. D. J.

* * *

RAILWAY CONTROL IN ENGLAND

The English government, having taken control of all the railways in Great Britain on August 14, 1914, agreed to pay the stockholders the same earnings as they had received in 1913. On account of the great number of men employed in the railway service having entered the Army or other occupations not suitable for women, the number of women employees of the British railways has risen in the past three years from 15,000 to 100,000. Freight cars have been pooled without regard to ownership, and the loading and unloading of cars has been expedited by heavy penalties and fines, and even imprisonment. It has been made a criminal offense to fail to load and unload in accordance with the rules. Many passenger trains have been removed from the schedules, reservation of seats has been abolished, and the passenger rates advanced 50 per cent with a view, not to increase the revenue, but to discourage travel. The staff of each railway remained undisturbed. Wages, hours of work, and other labor questions are settled by conciliation and arbitration, and, on the whole, the management and the employees have worked in harmony.

REQUIREMENTS AND TREATMENT OF CANADIAN HIGH-EXPLOSIVE SHELLS

Canadian high-explosive shells must possess an elastic limit or yield point of 19 tons per square inch, and an ultimate breaking strength of not less than 35 tons and not more than 50 tons per square inch, with an elongation in 2 inches of not less than 14 per cent. The maximum carbon content is 0.55 per cent; and while there apparently is no minimum, the forging companies are not required to accept anything under 0.4 per cent. The minimum manganese content is 0.4 per cent and the maximum 1 per cent. Sulphur and phosphorus must be under 0.05 per cent and silicon under 0.3 per cent. The shells are forged from either rolled or cast blanks; while many of the 4.5- and 6-inch shells have been forged from cast blanks, the tendency is to produce these types from rolled stock. The 6-inch shells and under are forged with a solid base.

For the forging operation, the blanks are generally heated to a temperature of from 2000 to 2200 degrees F., either in large continuous furnaces or in smaller batteries where the shells are all brought up to a forging temperature together. The piercing, as a rule, is done in one operation and the shells are then cooled; this cooling is either retarded or accelerated according to the carbon content. Where the carbon drops to 0.4 per cent, the cooling must be retarded as much as possible. Practice in this respect varies in different plants and for the different types of shells. As a rule, low-carbon heats are stacked in the open, considerable space being left between each shell for circulation of air. High-carbon heats are stacked closely, well protected from the air, and may be covered with

cinders or some similar medium to retain the heat. In no case is it permissible for the shells to be in contact with one another during cooling. Test pieces are taken from each heat after forging, and any heats failing to pass the specifications are set aside to be normalized or annealed. Rejected heats may be either too weak or too strong, and must be brought up or toned down. Failures generally occur in those heats close to the minimum and the maximum carbon content. Low-carbon heats that fail to reach the minimum breaking strength and are low in elastic limit and high in elongation should be brought to a heat slightly above the critical point and cooling accelerated. High-carbon heats that show too great a strength and a low elongation should be heated up to but not beyond the critical point and cooled slowly. It is not often that rejected heats fail to respond to the annealing treatment. Some low-carbon, low-manganese heats failing to respond to ordinary air-cooling have been brought up to strength by forcing cold air into the interior of the shell and against the exterior.

A Canadian shrapnel shell recently made contained 0.52 per cent carbon and 0.75 per cent manganese. After it was heated to 1550 degrees F., quenched in oil, reheated to 1000 degrees F., and cooled in air, its elastic limit was 42 tons per square inch, ultimate breaking strength 70 tons per square inch, and elongation 15 per cent in two inches. In the heat-treatment of these shells the temperatures vary from about 1450 to 1600 degrees F. for quenching, and from 800 to 1100 degrees F. for tempering, depending on the carbon content. Ordinarily twenty minutes is about the average time required to heat the shells for quenching, but a little longer time is needed for tempering.

* * *

Canadian manufacturers now produce 800,000 complete shells every week, which is more than was produced, before the war, by any nation except Germany.

ORDERING PARTS FOR MACHINE TOOL REPAIRS

BY W. G.

When it becomes necessary to obtain repair parts for machine tools, the man who has charge of repairing does not always specify exactly what is wanted. For instance, if some part is required for a planer, the requisition may simply refer to a planer built by the Blank Mfg. Co. This requisition is sent to the purchasing department and the order received by the planer manufacturer will probably read "One gear for planer of your make." Now the Blank Mfg. Co. may have been in the planer business for fifty years, and during that time machines have been constructed in perhaps twenty different sizes, to say nothing of the various designs of each size; consequently the first question that confronts the Blank Mfg. Co. in attempting to fill the order for a repair part is what particular planer this gear or other part is for. As the order is very indefinite, it is necessary for the planer manufacturer to obtain additional information. Perhaps one week has al-

Owner's Shop Number_____
Name of Tool_____
Maker's Name and Address_____
Manufacturer's Shop or Serial Number_____
Purchase Order No._____
Machine Received_____
Foundation Plan Numbers_____
Remarks_____

Machinery

Card Record used when ordering Repair Parts from Manufacturer to enable Machine to be identified readily

ready elapsed since the break-down occurred, thus putting the machine out of commission.

The present-day practice of some manufacturers is to attach to their machines a brass nameplate on which is the manufacturer's address, his shop or serial number on which the machine was built, and possibly the following instructions: "When ordering repair parts refer to this number." When this practice is followed the manufacturer has definite information as to what particular machine repair parts are needed for, and unnecessary delays are avoided. This custom of attaching a plate is comparatively new, so that what benefits will be derived therefrom remains to be seen.

In any one shop, such, for example, as an average-size railroad shop, there are likely to be several different machines of the same general type but of different makes, and these may have been purchased during a period of, say, twenty or thirty years. If no record is kept of the machines obtained from time to time, mistakes and delays will often occur in securing repair parts, especially if the shop engineer or whoever has charge of repairs is a new employe and is not familiar with changes that may have been made in the machine after it was purchased from the manufacturer. In order to enable a manufacturer to identify any machine readily, it is suggested that a card record of the new machine be kept for future reference. This card might be arranged as shown in the accompanying illustration. Each part could be numbered to correspond with the owner's shop number of the machine and contain, in addition, the name of the tool, the manufacturer's name and address, and the other information indicated on the sample card.

Frequently the owner of a machine tool changes the construction somewhat or adds a special fixture or attachment, and when this is done a record of the changes should be added to the record card under the heading "Remarks," in order to avoid the possibility of ordering repair parts from the manufacturer to replace parts that were incorporated in the design of the machine by the owner and not by the original manufacturer. Suppose, for example, that a planer was purchased in 1900 and that since that time there have been several foremen of repairs, so that the man now in charge simply knows that this particular planer is in the shop. Suddenly something happens to the machine and inspection shows that it will be

necessary to obtain some parts from the manufacturer. Even if there is a nameplate on the machine or other means of identification, the plate or symbol may be invisible because of grease or dirt and the repair foreman will not know where to look for it. If the practice of designating each tool with a shop number and with a record card kept in the office has been followed, the foreman can, without loss of time, obtain information that will enable him to write out a definite requisition for repairs.

While it is easy to compile such a record at the time machines are purchased, obtaining the necessary information and data for machines that have been in use some time will require some little investigation, but the effort and cost may be slight as compared with the advantages. One method of obtaining a record of machines already in use is as follows: A list is made out of the machines of any one manufacturer, containing the name of each machine, the different sizes or general dimensions, and any other information which is considered essential in enabling the manufacturer to identify each particular machine. This list is sent to the manufacturer, who is requested to send the shop or serial order number of each machine and any other useful data.

Within the last two or three years there have been more than the usual number of machine tools sold as second-hand, and many of these machines have needed immediate repair. When repair parts have been ordered for these machines it has been the exception rather than the rule for the owner to give the manufacturer a definite order that would enable the machine to be identified readily. When ordering parts for a second-hand machine, the owner should mention the fact that the tool was bought second-hand and give, if possible, the name of the original owner. Sometimes the original owner of a tool which has been sold second-hand has put a plate onto it on which is marked the shop number. If this plate is not removed when the tool is sold again, the number on it is occasionally used when ordering repair parts from the manufacturer, who, of course, knows nothing about the number or what it refers to.

* * *

CANADIAN CRIPPLED SOLDIERS

In an article in *American Industries* attention is called to the fact that too exaggerated a picture of the number of maimed soldiers that will return from the front has probably been drawn. Canada has sent about half a million men into the field in three years. A considerable number of these went into the war at the very beginning. During the first three years of the war the number of men returned who had undergone amputation was less than 900, and the total number blinded was 32. About 90 per cent of all wounded who have returned are capable of going back to their old jobs. In France it is stated that 99 per cent of the wounded return to their previous occupations. The same percentage may be expected in Canada when all the wounded have returned, because so far only those more seriously disabled have been sent home.

Of the 200,000 men that have been sent by the Province of Ontario, about 9000, or 2 per cent, had returned up to October, 1917, because of being incapacitated for service by wounds. Of these, only 1 had lost both hands, 101 had lost one arm, 4 were blinded, 72 had lost one eye, 13 had lost one hand, 12 had lost one foot, 6 had lost both legs, and 3 were still more seriously maimed. It is believed that there are more men seriously injured annually in the American industries than may be expected in a year's war. Hence it may be that the problem that will confront the country after the war with regard to maimed and crippled soldiers is not as serious as has been expected. In this, modern warfare probably differs from former wars; it kills rather than maims.

* * *

Great Britain now receives \$400,000 a month for the "waste" of its army kitchens in Great Britain and France. From this waste is made, besides candles and fertilizer, enough soap for the army, navy, workhouse, asylums and other public institutions, and enough glycerine to provide the propellant for 17,000,000 shells per year.

LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

CRANKSHAFT TURNING FIXTURE

A heavy crankshaft is a difficult job of machine work, unless the proper fixtures are provided to hold it firmly and to facilitate setting up. Figs. 1, 2 and 3 show a crankshaft turning fixture for an engine lathe that I used successfully a few years ago when working on heavy crankshafts. The fixture consists of two parts, a plate and a sliding head. The plate is made with a projection on the back that fits into a counterbore in the faceplate of the lathe. The front face of the plate is made with two T-slots, and a center groove runs the full length. The sliding head is provided with a tongue that fits into the center groove, and it is held firmly in place by four bolts engaged in the T-slots. The side of the head is graduated, and it is set at zero when the shaft is centered in the faceplate. The head is bored to some size, say six inches, if that happens to be the size of the crankshaft to be clamped. If the fixture is used for shafts smaller than six inches, a split cast-iron bushing may be used as a reducer.

When the fixture is set up to turn the crankpin, the four bolts are loosened and the head is dropped to the required throw, using the graduation on the side to set the crank center at the required position. The outer end of the crankshaft is swung on a false center in a bracket that is clamped to the shaft. The fixture, because of its rigidity, serves to locate the bracket and the center accurately and makes a lay-out unnecessary. When offset, a weight is required on the faceplate to counterbalance the shaft.

It will be found that by turning the crankshaft with this fixture it is unnecessary to drill or slot out the metal between the crank web, as it can be turned out much more quickly on the lathe than by any other method known to the writer. Fig. 3 shows the fixture clamped in the center of the lathe faceplate, ready for boring to fit the crankshaft; Fig. 2 shows

the shaft clamped in position for turning the bearings; and Fig. 1 shows the fixture offset for the required crank throw. Springfield, Ohio

C. W. FRANCIS

METRIC SYSTEM IN WATCH INDUSTRY

If the metric system of measurement is to replace the present system with the inch as a unit, the change should be made with the least amount of confusion possible. This can be attained by using the centimeter as the unit of measurement in general machine practice and not the millimeter, as is the custom in Europe and South America. After being accustomed to the inch as a unit, to change abruptly to so small a unit as the millimeter is not practicable. But adopting the metric system as it is used in the watch industry in Waltham, Elgin, Lancaster, etc., need cause no confusion, but merely an adjustment in tools and measuring instruments. The millimeter is not referred to, but is called one-tenth of a centimeter, that being the unit of measurement. For instance, the diameter of the famous French 75's will not be spoken of as 75 millimeters, but as 7.5 centimeters. Reduced to its simplest form, measurements are stated in tenths, hundredths and thousandths of a centimeter, instead of an inch, thus eliminating all common fractions and the tenths of thousandths of an inch used on the English micrometer. As the screw of the metric micrometer is of finer pitch, much closer work can be done without the sensitive touch necessary when using the English micrometer in tenths of thousandths.

Another difference between the European and the watch-industry use of the metric system is in threads. For instance, the watchmaker speaks of, say, ten threads per centimeter, the European usage is to speak of a one-millimeter thread, or a decimal thereof. One other point in favor of the adoption of this system is that the measurements are finer, so that

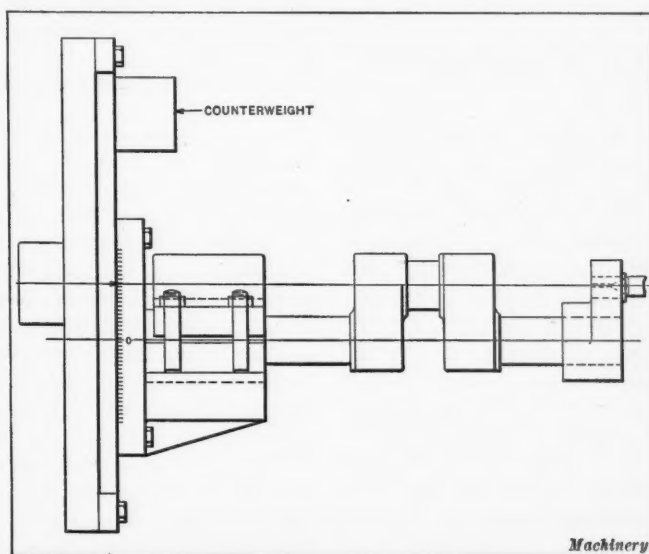


Fig. 1. Crankshaft Fixture in Offset Position for turning Crankpin

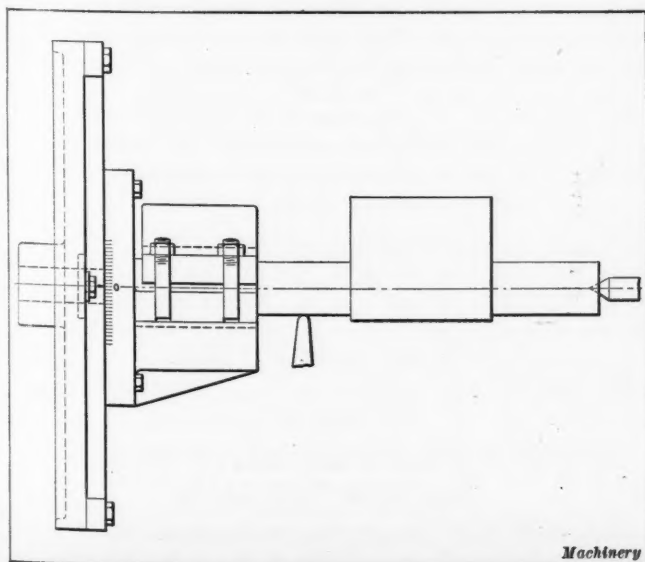


Fig. 2. Crankshaft Turning Fixture in Position for turning Bearings

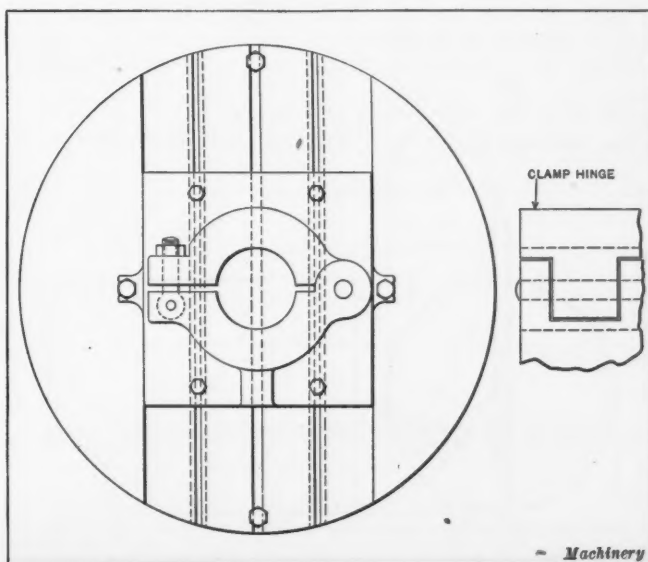


Fig. 3. End View of Crankshaft Fixture, showing Hinge and Clamp

reamer and mandrel sizes run closer together, making possible almost any English measurement; this is a great convenience in repair work. Reamers should vary by 0.005 centimeter up to 0.5 centimeter in size; then by 0.01 centimeter up to 1 centimeter; by 0.05 centimeter up to 2 centimeters; and by 0.1 centimeter up to 5 centimeters. Mandrels should be developed on the principle of a continuous taper; they will then fit almost any hole whether it is measured by the English or the metric system.

To one who has never employed the metric system, as used in the watch industry, the utility and simplicity of its measurements are equivalent to a lost art; the system must be used to be appreciated. By its extensive use, the numerous number gages, such as Stubbs, wire, paper, music-wire, and others, will be eliminated.

Jersey City, N. J.

WARREN H. DUNBRACK

FINDING CONTENTS OF CYLINDRICAL TANKS

The writer is in the employ of a company manufacturing cylindrical oil and gasoline tanks that range in capacity from 10 to 40,000 gallons. With each tank a wooden gage stick is furnished for measuring roughly the contents of the tank. These gages are divided into from twenty to one hundred parts, depending on the size of the tank in which they are to be used; the graduations read in even number of gallons. The method of using these gages is shown in Fig. 1. It can readily be seen that the graduations on the gage will in no place be of equal length; even the divisions on each side of the center are not symmetrical unless the total capacity of the tank is exactly divisible by the number of gallons by which the graduations advance. The task of computing the lengths of the graduations for these gage sticks will be realized when it is stated that 20,000 computations were necessary to meet all these conditions, and when the lengthy, complicated equation for the solution of a segment of a circle is recalled.

The writer thought that a graphic method of deriving these graduated lengths would be sufficiently accurate and require less time than the analytic method. So the simple curve of Fig. 2 was plotted and found to be so broad as to be applicable to any depth in any tank of any diameter and any length, when supplemented by two settings of the slide-rule. It was also found that to construct a chart that would give the entire solution without recourse to the slide-rule would be a task almost as large as that of the original problem.

The curve can be constructed in an hour's time, by the use of the tables found in any handbook giving the area of segments, to any scale depending on the desired accuracy of the results. The original was constructed as follows: A tank thirty inches in diameter was assumed, and the total number of gallons in a section of this diameter and one inch thickness was computed thus:

$$\frac{\pi \times (\text{radius})^2 \times \text{length}}{231} = \frac{\pi \times \left(\frac{30}{2}\right)^2 \times 1}{231} = 3.06 \text{ gallons}$$

there being 231 cubic inches in a gallon.

The abscissa of the chart was laid off to 30.6 inches (scale

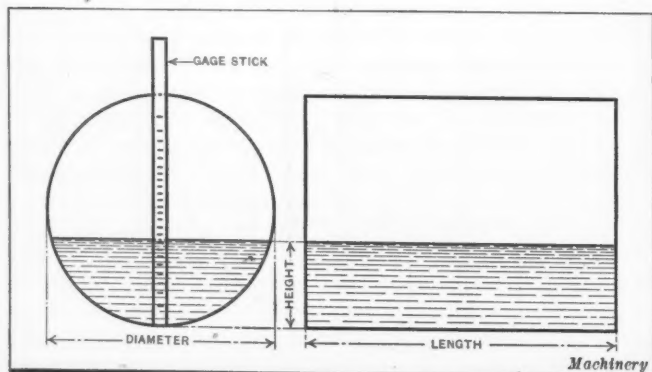


Fig. 1. Use of Gage Stick in Cylindrical Tank

0.1 gallon = 1 inch), and the ordinate to 30 inches, the diameter of the assumed tank. This gave a chart nearly square in its dimensions. Next, the heights to which the liquid would reach for thirty conditions were computed, and a curve constructed through the points laid off with these values. Thus it was desired to locate the point on the curve for 30 per cent of the total capacity. As 30 per cent of a section, one inch thick, through the tank is $3.06 \times 0.30 = 0.918$ gallon; 0.918×231

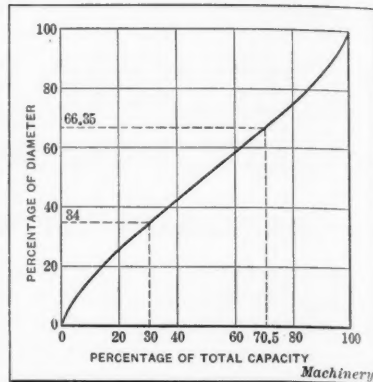


Fig. 2. Chart for graduating Gage Sticks

$= 212$ square inches in segment of circle. Then,

$212 \div d^2 = 212 \div 30^2 = 0.2355$. The rise of this segment divided by the diameter is equal to 0.34, which is also the percentage of the diameter, which locates the point $30 \times 0.34 = 10.2$ inches above the abscissa. In this manner thirty points were obtained and a smooth curve drawn through them.

Example—Lay out a gage stick for a tank 50 inches in diameter and 100 inches long, having a total capacity of 850 gallons, the gage to be graduated by 20 gallons. For example, to what height in the tank would the first 600 gallons reach? Dividing 600, on the slide-rule, by 850 shows this to be 70.5 per cent of the total capacity. This 70.5 per cent ordinate intersects the curve at the same point as the horizontal line for 66.35 per cent of the diameter. Multiplying, with the slide-rule, 50 by 0.6635 gives 33.175 inches as the length on the gage stick at which 600 gallons will be indicated. In this way each value can be quickly found. This curve may also be used for computing the area of a segment of a circle by merely considering the abscissa as the percentage of the total area instead of total capacity.

Fort Wayne, Ind.

CARLO M. EYSTER

TO FIND ECONOMICAL LENGTH OF STOCK FOR FOUR-SPINDLE SCREW MACHINE

Frequently, in multiple-spindle screw machine work, four bars of unequal length are in the machine and one bar of stock remains to be cut. The problem then arises of cutting this bar into four pieces of such lengths that all the stock will be finished at the same time, yet none of the spindles will be running empty while the others are finishing.

This can be solved by finding the difference in the lengths of the bars in the machine and then finding the amount that must be added to the longest bar. For example, the remaining bar is eight feet long. The difference between the longest and the next longest bar is nine inches; between the longest and the third longest bar is fourteen inches; and between the longest and the shortest bar is seventeen inches.

If x = number of inches to be added to longest bar;

$x + 9$ = number of inches to be added to next longest bar;

$x + 14$ = number of inches to be added to third longest bar;

$x + 17$ = number of inches to be added to shortest bar;

$4x + 40$ = amount to be added to all the bars.

As the remaining bar is 96 inches long, $4x + 40 = 96$; $4x = 96 - 40 = 56$ and $x = 14$. So the lengths into which the bar should be cut are $x = 14$ inches; $x + 9 = 23$ inches; $x + 14 = 28$ inches; and $x + 17 = 31$ inches.

Chicago, Ill.

CHARLES G. KEHOE

USING TAPER WEDGES IN CUTTING SQUARE THREADS

The writer often has occasion to cut either left- or right-hand square threads on spindles of $\frac{1}{2}$ or $\frac{3}{4}$ inch diameter, eight threads per inch. At first there was trouble in not

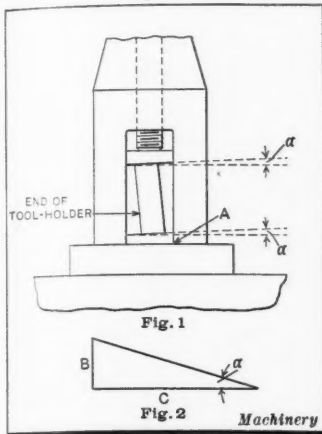


Fig. 1. Use of Taper Wedges in Toolpost. Fig. 2. Method of deriving Angle of Wedge

ing necessary only to change the direction of the slope of the wedge. The angle of this slope is the same as the helix angle of the thread and is found as shown in Fig. 2.

B = pitch of thread in inches;

C = external circumference of thread;

$\frac{B}{C} = \tan \alpha$ = helix angle.

In the case of a $\frac{3}{4}$ -inch diameter screw with eight threads per inch the calculations would be as follows:

$$B = 0.125 \text{ inch}$$

$$C = \frac{3}{4} \times 3.1416 = 2.3562 \text{ inches}$$

$$\tan \alpha = \frac{0.125}{2.3562} = 0.05305$$

$$\alpha = 3 \text{ degrees (approximately)}$$

A slight side clearance is ground on the tool to allow for any difference between the helix angle and the angle of the wedge, and to prevent the tool from rubbing against the side of the threads.

Worcester, Mass.

C. ANDERSON

STRAIGHTENING RODS AND TUBING

In a certain shop an everyday job is to straighten $\frac{1}{8}$ -inch steel rods from 18 to 26 inches long, the rods being either tempered spring wire or drill rod, much like knitting needles, which is so hard that a tool will not cut it. These rods are commercially straight, but are required to be within 0.0015 inch true, and up to the present time no maker of straightening machines has been of assistance. The springy nature of the material, the degree of accuracy, and the fact that accuracy is particularly desired near the ends have been the stumbling blocks. As a consequence, men are doing hand work on these rods. A square cast-iron block, 3 by 3 by 24 inches, is planed on all four sides and set up so the top is level with the eyes when seated. The men roll the rods on these blocks and straighten by the use of a four-ounce hammer. The best straighteners are men past fifty years of age. Much of the work is done at night with a sheet of white paper for a background and a light back of it. As many as 185 spring steel rods per day of nine hours are straightened, and about 140 drill rods.

The same method is used to straighten brass tubing in lengths a little longer. A typical size is $\frac{3}{8}$ inch outside diameter with 0.040 inch wall thickness. The blocks are made slightly concave in the direction of their length, and on this the tube is hammered straight. Some will think that this dents the tube, and it does, but not any more than the amount the tube is out of round as it is drawn, which is only a few thousandths inch. The thick wall helps to preserve the shape. Another method was used to straighten steel tubing $1\frac{1}{4}$ inch outside diameter, with a $\frac{1}{64}$ -inch wall, that was used for printing press work. A mandrel was made to be just pushed into the tube, and when the high spots had been determined it was forced in with a mallet and the tube carefully hammered on those spots. This was a good scheme, because it was

known that the tube was straight when the mandrel was jarred out. However, on the tubes that were to be inking rollers the little flat spots left by the hammer were objectionable, and the only alternative was to sort the stock. D. A. H.

REMOVING IRON PLATE RUST

In the October, 1917, number of MACHINERY, page 155, in the article entitled "Removing Iron Plate Rust," the following statement was made: "It consists in applying to the surface of the iron a mixture of two parts of finely crushed sodium bisulphate (sodium acid sulphate, $\text{Na}_2\text{SO}_4 \cdot \text{H}_2\text{SO}_4 \cdot 3\text{H}_2\text{O}$) and one part of common salt, which is moistened just enough to make it cohesive." There is an error here, as the chemical formula given is not that of sodium bisulphate or sodium acid sulphate. Sodium bisulphate is a definite chemical salt having the formula NaHSO_4 . It is a weak, unstable compound, decomposing in the presence of moisture into sodium sulphate and sulphuric acid. The formula given in the October number of MACHINERY is not a salt, but a mechanical mixture of sodium sulphate and sulphuric acid, which is the same as the decomposition products of sodium bisulphate, and identical with the product known in the chemical trade as "salt-cake," the residue remaining after the treatment of sodium chloride with sulphuric acid in the manufacture of hydrochloric acid. The action of either the sodium bisulphate or the mixture mentioned would be the same, with the exception that the bisulphate would act more slowly. The cleansing action is due to the fact that the sulphuric acid acting upon the common salt (sodium chloride) liberates chlorine in the form of hydrochloric acid, which has a remarkable affinity for iron. For this reason it is commonly used as a cleaning dip for iron and steel. The sodium sulphate is a stable compound, inactive under the circumstances, and may be considered simply as a vehicle. Either sodium bisulphate or salt-cake would probably produce the effect desired in the way of removing rust, so that the error in the previous article is merely that of giving to the bisulphate the formula for salt-cake.

Rutherford, N. J.

A. SCHLEIMER

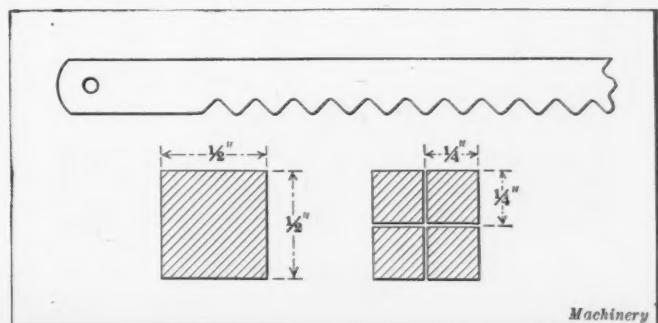
CUTTING AN OILSTONE

After completing the machining and hardening of two dozen small dies to be used for drawing purposes, lapping these dies was the next operation. The writer generally used a $\frac{1}{4}$ -by $\frac{1}{4}$ -by 4-inch india oilstone for this purpose, but discovered that he did not have a stone of this size on hand. He did have some $\frac{1}{2}$ -by $\frac{1}{2}$ -by 4-inch stones, but anyone who has worked hour after hour lapping dies with a $\frac{1}{4}$ -inch stone and then is called upon to lap a set of dies much smaller in size than those he has worked on, with a stone that is double the size of the one that he has been accustomed to use, will realize that the change is a handicap in producing good work and, perhaps, a waste of more than half the stone.

The writer experimented. The oilstone was cut with a hacksaw, but not with the ordinary commercial blade. Teeth the shape shown in the illustration were ground on a 9-inch thin blade on an emery wheel. A lubricant of one-third water and two-thirds turpentine was used, a few drops at a time. The saw was made and the first stone cut in forty minutes; the cutting of the remaining stones was done by an apprentice.

Kenosha, Wis.

M. E. DUGGAN

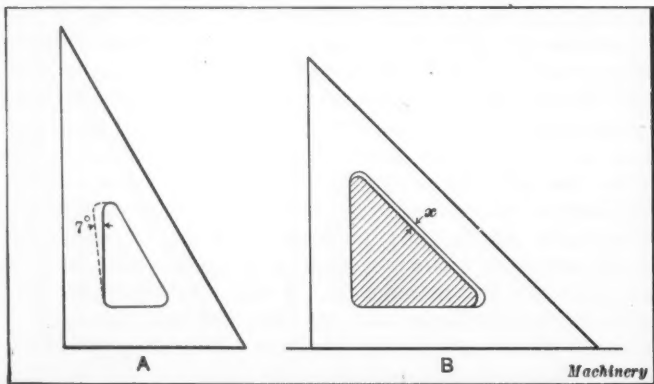


Hacksaw Blade and Cross-sections of Oilstone

IMPROVED TRIANGLE — SPACING BLOCK FOR CROSS-SECTIONING

An improvement that can be made upon the draftsman's 30- by 60-degree triangle is indicated at A. The inner edge on one side is given an inclination of 7 degrees, as indicated by the dotted line. This 7-degree angle is used almost universally for the draft of drop-forgings and it is also extensively used on pattern drawings. As the illustration shows, this change does not injure the triangle by weakening it.

A kink for cross-sectioning drawings was published in the November number of MACHINERY on page 249. In the December number on page 347, this method was criticized and the writer believes that the criticisms were well taken. Few companies will tolerate the use of the method suggested, because of the time required. In fact, some companies eliminate the cross-sectioning entirely. Occasionally there is a demand for work of extreme neatness, as when illustrations are required for catalogues and folders, and then some method of uniform cross-sectioning is desirable. The wooden block shown at B in the illustration is recommended as a simple method of



(A) Triangle having a Seven-degree Edge for drawing Draft Lines.
(B) Spacing Block for Uniform Cross-sectioning

making neat and uniform section lines. This block is about 3/16 inch thick, and in using it the triangle is held with the thumb and the block with the fore-finger. The block and triangle are moved alternately, thus giving a uniform spacing. The space x should be about 3/64 inch if the section lines are to be 1/16 inch apart. This block does not have the disadvantage of sliding over the lines drawn. C. A. C.

STOCK BIN FOR CASTINGS

A flexible stock bin for castings or forgings is shown in Fig. 1. It can be made of any height by adding boards, and the size of any compartment can be increased by removing the boards of the adjacent compartments. The bin is easily made and stands considerable wear. It consists of thick boards held in place by channels riveted together as shown in Fig. 2. Angle-irons are placed across the upper ends of the channels to form the front and back, and these sides are held together

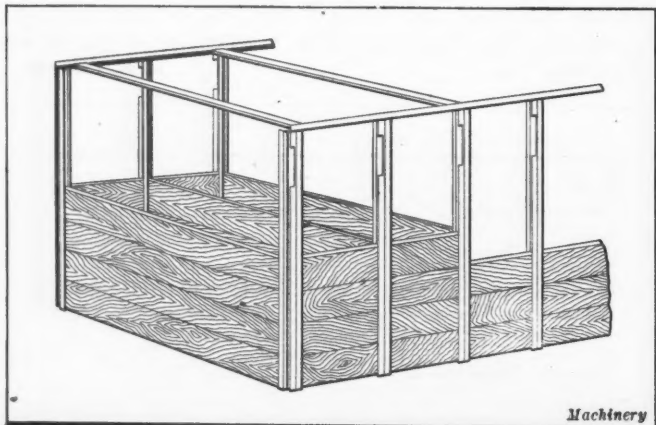


Fig. 1. Flexible Stock Bin for Castings or Forgings

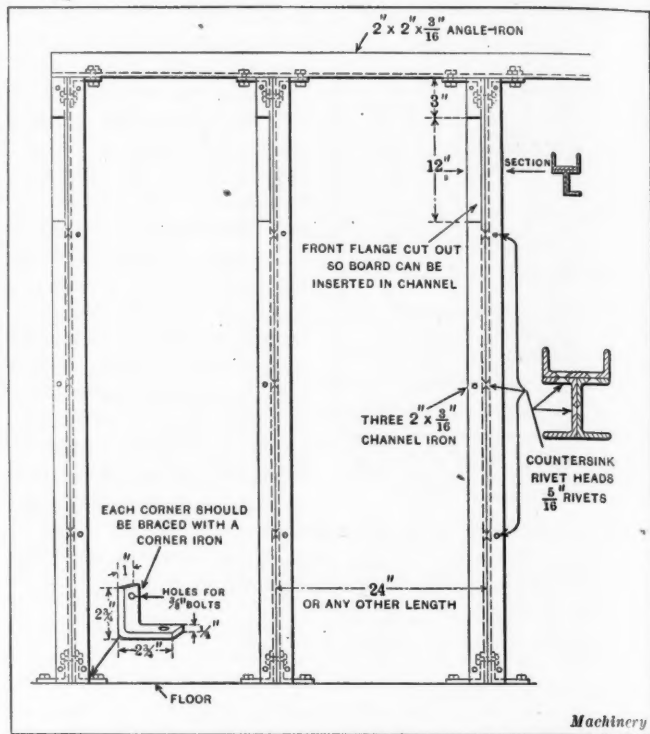


Fig. 2. Details of Flexible Stock Bin

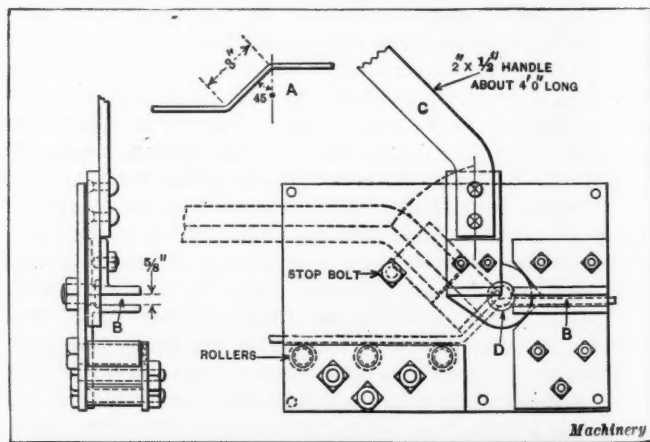
by iron bars, across the top, the ends of which are twisted at right angles to the body and secured by the same bolts that secure the upper corner iron at every other section.

Flint, Mich.

C. C. SPREEN

BENDING CONCRETE REINFORCING RODS

The illustration shows a machine that has been useful in bending reinforcing rods for concrete. These rods are 3/8 and 1/2 inch square, range from ten to forty feet long, and may have any number of offsets as shown at A. The rods are placed between two angle-irons at B, and handle C is pulled down to the position indicated by the dotted lines, thus forming the two bends at one operation as indicated. When the



Bending Concrete Reinforcing Rods

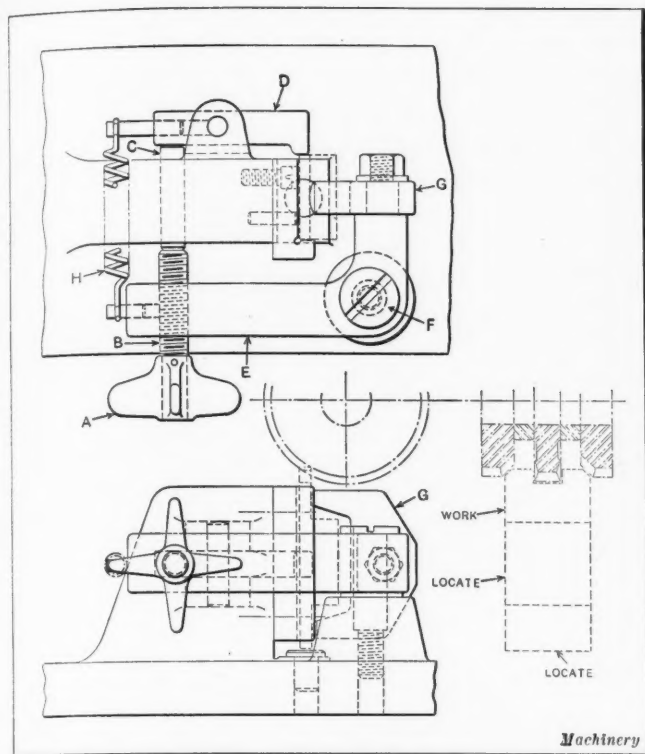
rods are small, three or four may be bent at one time. The handle rotates about a hardened pin and hardened bushing at D. This machine was made from scrap material, and was therefore inexpensive.

St. Joseph, Mo.

L. M. HAMLET

RAPID CLAMPING DEVICE

The writer recently designed the three-point binding clamp shown in the illustration. By turning the winged nut A, which is pinned to stud B, pin C is forced against clamp D, causing it to clamp the work at the other end. As soon as clamp D begins to bind, the clamping arm E, being pivoted by pin F, rides back on stud B, causing the equalizing clamp



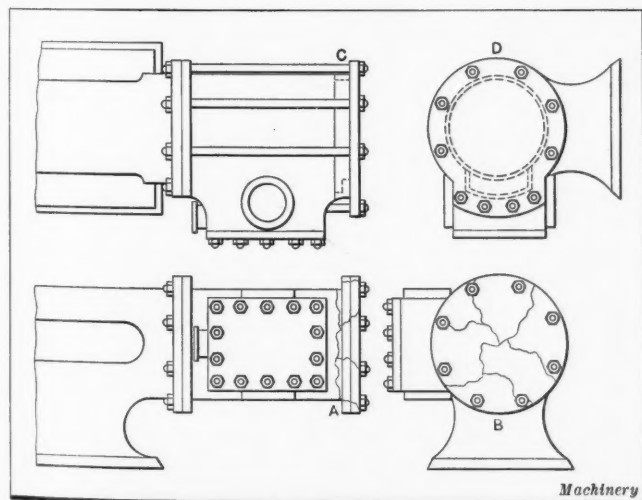
Three-point Binding Clamp

G to hold the work in front at the top and bottom. By turning nut A in the opposite direction, the clamps are loosened and spring H pulls clamp D back so that the work may be easily removed.

B. A. C.

STEAM ENGINE CYLINDER REPAIRS

The accompanying illustration shows what happened to an old 14- by 18-inch slide valve steam engine when the piston-rod pulled out of the piston while the engine was running at full speed, and on the return stroke shattered the rear cylinder



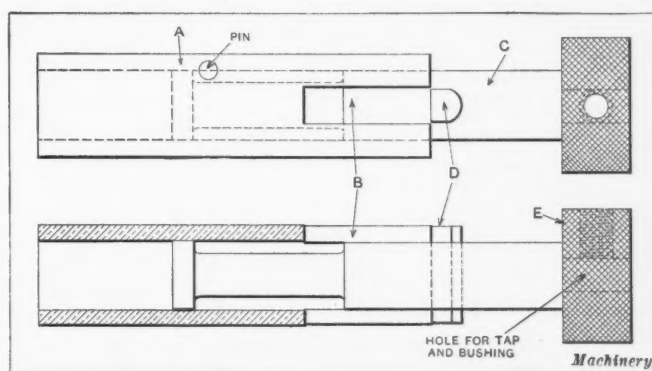
Broken Cylinder Parts and New Pieces

head, cylinder flange, and cylinder barrel up to the inner edge of the counterbore as shown at A and B; the illustration also shows how the repairs were made. Immediate repairs were necessary, and so the cylinder was taken to the shop and bolted onto the faceplate of a 40-inch lathe. The broken end of the cylinder was faced off to the inner edge of the counterbore, which, of course, exposed the steam port but gave a smooth face about $\frac{3}{4}$ inch wide around the cylinder barrel and steam port. A pattern was made for a casting (shown at C and D) that would form the head and that part of the barrel taken up by the counterbore. It was bored out to the original size of the counterbore and faced off. Dowel-pins were set to locate it true with the cylinder and to facilitate the assembly. Holes were drilled through the flange to coincide with the

tapped stud holes in the front cylinder flange, with the exception of those directly in line with the steam chest where holes were drilled for studs which were tapped into the steam chest wall. The tapped stud holes in the front cylinder flange fortunately came outside the cylinder barrel, and these were drilled large enough to admit long stud bolts that extended from the flange on the engine frame, through the front cylinder flange, and back through the new casting flange, giving a sort of squirrel cage effect. An annealed gasket of 1/32-inch copper was made for the new joint, and with a new piston-head, rod, and connecting-rod strap, the engine was assembled and put into operation without any trouble being experienced. JAY

SMALL TAP-HOLDER FOR TURRET LATHE

In doing small jobs on a turret lathe that was too large for the work, considerable difficulty was experienced in tapping with small taps, as the tap-holders were lacking in sensitiveness, which resulted in an unusual amount of breakage. The size of the tap used in this particular work was 1/16 inch. To



Tap-holder for Use on Turret Lathe

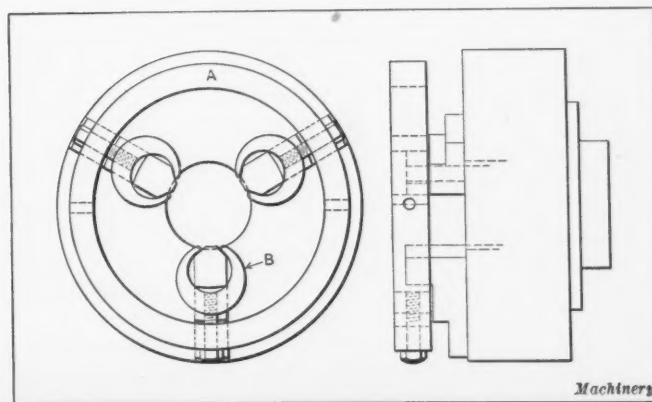
eliminate this excessive breakage, a releasing tap-holder was designed which is here illustrated. It consists of a tube or sleeve A, having a slot milled as shown at B. The inside member C holds the tap and is pulled out of the sleeve by the tap. The pin D slides in the slot B and prevents the inside member from rotating until the tap has entered the work so far that the pin no longer engages the slot, this distance being regulated by a stop on the turret. The tap then rotates with the work and ceases to advance. It is withdrawn by reversing the lathe and grasping the knurled head E with the fingers.

Boston, Mass.

JOHN A. SHAND

LATHE-CHUCK TRUING DEVICE

The truing device here shown is a simple, inexpensive, accurate method of truing lathe-chuck jaws. It consists of a large ring A, three small eccentric rings B, and three ordinary cap-screws. In the large ring, holes are drilled so that three or four screws may be set equidistant from one another, the holes being drilled a free fit for the screws. The eccentric rings B are milled out to fit on the inner angle of the jaws and tapped opposite the opening for the cap-screws. The fixture is placed



Inexpensive Method of truing Chuck Jaws

on the chuck and the jaws tightened to give them the proper stress; in this way the grinding wheel can pass the entire length of the jaws. This device can be used equally well on four-jaw chucks by using four eccentric rings *B* instead of three, as here shown. The outside of the jaws can be ground by placing plain rings on the different steps or by wrapping ordinary soft wire around the outside so that it will be in the corrugations, and then reversing the tension of the jaws.

Detroit, Mich. O. F. SCHWEITZER

SIMPLE SECTION LINER

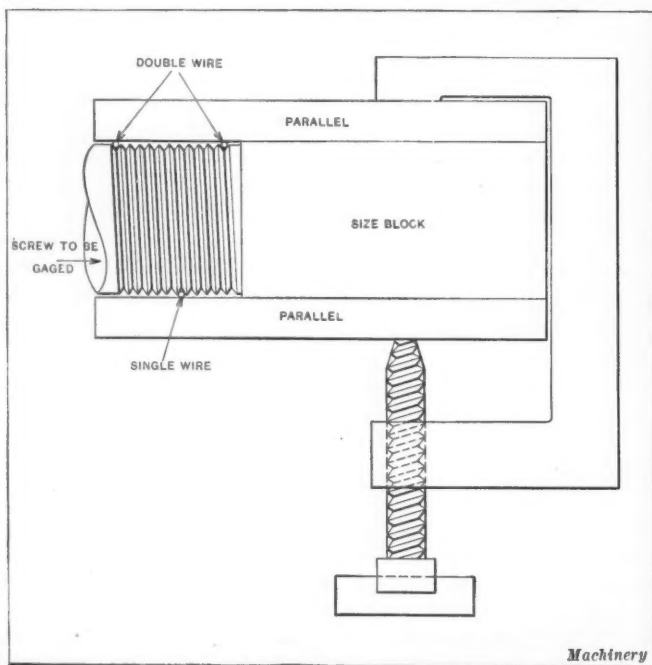
In the November number of *MACHINERY* was given a kink for cross-sectioning drawings by means of a triangle. The following suggestion may also be of interest: Two screws 6 inches long, $\frac{1}{2}$ inch in diameter, with sharp V-threads, were turned up, one having 32 threads per inch and the other 16 threads per inch. On a small drawing, by using the 32-thread screw in the proper location and exerting a slight pressure, each section line is evenly and properly located. Then with a 45-degree triangle the lines may be drawn rapidly in the usual manner, thus giving a neat, even appearance. For large drawings the 16-thread screw is used.

North Plainfield, N. J.

JOHN B. GRAY

MEASURING DIAMETERS OF SCREW THREADS

The diameters of screw threads are usually measured by using the regular Brown & Sharpe thread micrometer or by means of three wires used with the regular flat-anvil micrometer. Of these, the thread micrometer is the more reliable. However, by substituting a sizing block for the micrometer in the



Device for measuring Diameter of Screw Threads

three-wire system an accurate measurement can be obtained. First the diameter of the screw, including the wires to be used, is found. Then a sizing block is made to the dimension obtained; also a pair of parallels, hardened and ground, about one-fourth by one-half inch and one inch longer than the block. A C-clamp for holding the parallels and block together completes the outfit, and a measuring surface at least five times greater than that of the micrometer is obtained. The screw to be gaged is placed between the projecting ends of the parallels, and by placing two wires, as far apart as possible, in the threads of one side of the screw there is no danger of measuring out of square with the screw. On the opposite parallel, the single wire can be moved from one thread to another and any variation can be easily detected.

If, in placing the screw, block, and parallels on the

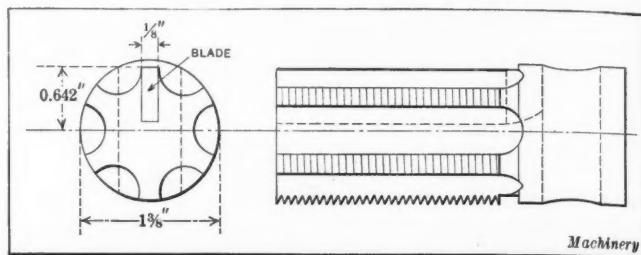
surface-plate, the center of the screw is found to be higher than the parallels, it will be necessary to pack up the block and parallels enough to bring the center of the block about the same height as the center of the screw. The placing of pieces of thin packing, such as tin foil, tissue paper, etc., between one of the parallels and the size block will enable the screw to be measured if it should be over size.

Derby, Conn.

F. W. SHRIER

TAP WITH INSERTED "DUTCHMAN"

A lot of Whitworth thread taps were found to be cut a trifle too deep, so that the root diameter of the tapped hole was too small and would not allow the thread gage to enter. Rather



Tap with Inserted "Dutchman" for correcting Root Diameter

than junk them, they were annealed and a block was inserted, as shown in the illustration, and ground to the root radius. All holes that were too small were then reamed, by this blade, to the proper size.

Boston, Mass.

JOHN A. SHAND

COST PLUS TEN PER CENT

The editorial entitled "Cost Plus Ten Per Cent" in the January number of *MACHINERY* was of interest to the writer, who has been engaged in munition work for some years past with a number of different concerns. After being pushed to the limit in shops with regular contracts in an effort to get a greater production and meet delivery dates, it was a relief to get into a cost-plus shop in the capacity of chief tool designer. We were supposed to tool up for the production of 20,000 three-inch shells per day in the least possible time, but, strange to say, everyone seemed to take life easy. Not once during the time he was there was the writer asked to crowd the job, to get a little more out of his men, or to work overtime. This showed plainly that no particular effort was being made on the part of the management to hurry production, as would have been the case had the shop been working on the regular contract basis.

D. B.

TANKS ANTICIPATED

That there is nothing new under the sun is exemplified once more by the discovery that the famous British tanks so effectively used in Flanders were anticipated by that universal genius of the Renaissance, Leonardo da Vinci. Writing to Ludovico Sforza, Duke of Milan, more than four centuries ago, he offered to make known various engineering secrets that he thought would be useful in war. His sixth item was: "I can also construct covered wagons, secure and indestructible, which, entering among the enemy, will break the strongest body of men; and behind these the infantry can follow in safety and without impediment." Among other devices that Leonardo mentions are bombs, mines, and "powders or vapors for the offense of the enemy."

South Orange, N. J.

MAX J. HERZBERG

MACHINE LEG DESIGN

It would be a good thing if manufacturers of machines that stand on legs would make the legs A-shape and have the cross-piece not over six inches from the floor. Anyone who has tried to move a thousand-pound machine with a bar when the nearest point of contact available is a foot above the floor will appreciate this.

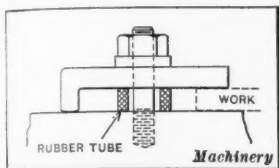
D. A. H.

SHOP AND DRAFTING-ROOM KINKS

STORING DRILL RODS

The writer has found that the following system of keeping drill rod is quite satisfactory. The drill rod is cut into 3-foot lengths, and each size is kept in a can made of sheet tin. These cans are all 3 feet in length, but vary in diameter from 1½ to 5 inches. The size is stenciled plainly on the lid. New York City

E. J. HIGGINS



Use of Rubber Tubing in Place of Spring on Clamping Device

Newark, N. J.

RUBBER TUBING FOR CLAMPING DEVICES

The accompanying illustration shows how a piece of rubber tubing was used in place of a metallic spring on a clamping device. This plan has been found to give very satisfactory results.

NILS ATTERBERG

SAVING TIME IN MAKING DRAWINGS

The writer has used successfully in two drafting-rooms what is called unprepared "Albanene" tracing cloth. Some concerns use bond and tracing paper for permanent drawings to save money and time; but paper in a short time and with ordinary usage becomes torn and the drawing has to be replaced. Drawings can be laid out directly on the cloth, and the prints obtained from it are good, if a relatively soft pencil, say a 3H or 4H, is used. The writer has also found that a triangle placed under a tracing facilitates the erasing of a line, and if a shield is used, a hole is seldom made.

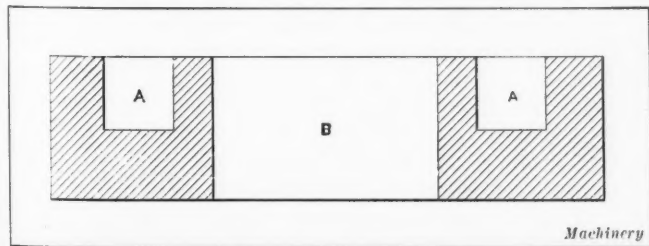
When a number of circles must be drawn from a common center, if a piece of celluloid about as thick as ordinary drawing paper is fastened by shellac over the center, a large hole will not be made in the tracing or drawing. Some people use horn centers, but these make holes in the tracing. The celluloid comes off easily by lifting with a knife. It has another advantage, that the center lines can be seen.

Roselle, N. J.

M. B. PERLMAN

SOLDERING FORM FOR ROTORS

In soldering the brass end-plates to the brass rods on three-horsepower squirrel-cage rotors, an electrical foreman rigged



Cast-iron Ring for soldering

up a soldering form as shown in the illustration, which consists of a cast-iron ring containing a recess A sufficient in size to accommodate the work. The end of the rotor shaft is slipped through the center hole B of the form, and the brass end-plate fitted into the recess A, which is filled with molten solder. This is an appreciable time-saver over other methods in use. Cincinnati, Ohio

JOSEPH PLOGMANN

HIGH-SPEED COUNTERBORES

At the present prices, it is seldom that purchasing agents will buy high-speed steel for use in counterbores. But in a large number of shops there can be found hollow-mills that are worn down too much for use on screw machines; these

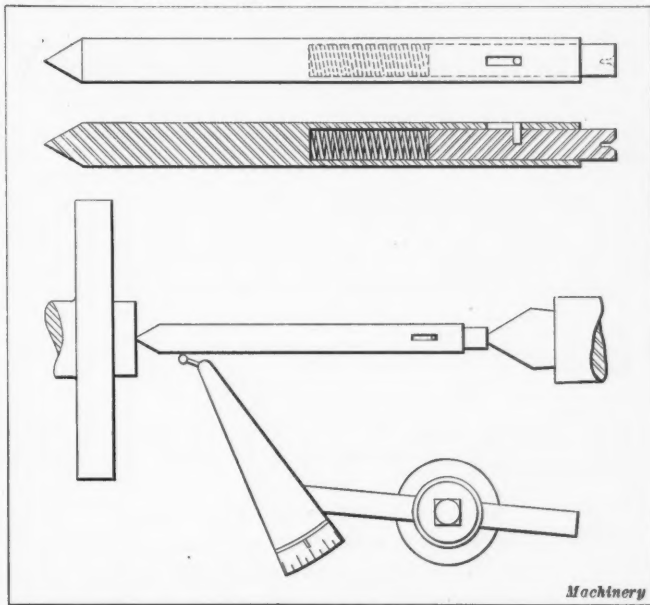
can be made into very good counterbores. They already have the teeth cut, so that all they need is to be fitted with a shank, from which the test that passes through the hole in the mill projects. Sometimes they may need turning to the right diameter, but as these mills have different sized holes and diameters, it is usually possible to select those that need very little work before being ready for use.

Providence, R. I.

ALFRED E. CARTER

CENTERING TOOL FOR LATHE WORK

For work that is laid out by the center points, such as holes in dies, the tool here shown is convenient for use in con-



Centering Tool for Lathe Work

junction with a test indicator as illustrated. The device is so simple as to need no description.

New York City

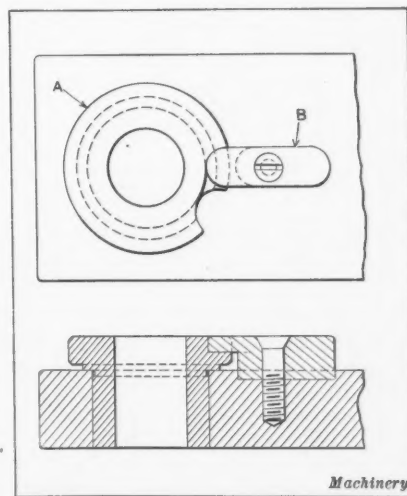
E. J. HIGGINS

SLIP BUSHING WITH RETAINING DEVICE

In the September, 1916, and April, 1917, numbers of *MACHINERY* locks for slip bushings were described. The accompanying illustration shows a slip bushing with a retaining device, which was used in drilling and reaming operations. The flange of the bushing A was milled through to the diameter of the key B. The bushing was then given a slight turn and the flange again milled to half its height. The key was secured to the jig by a screw. In order to remove the bushing, the knurled flange is given a slight twist until the flange can be withdrawn past the key by means of the milled groove. If the drill rotates counter-clockwise, the location of the key in the bushing will be in the opposite direction to that shown.

Ruelle (Charente) France

C. JOUVE



Slip Bushing with Retaining Device

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

QUARTER-TWIST BELTS

B. C. S.—I should like a good rule for quarter-twist belts, one that can be used for any case when the shafts are not parallel.

Answered by John R. Beckett, Somerville, Mass.

Here is a rule the writer has never known to fail: Have the pulleys so lined that the leaving faces are plumb. By "leaving faces" is meant the faces from which the belts leave the pulleys.

SEASONING CASTINGS

D. A. B.—High-speed production and the need of getting out special machines in the least possible time does not allow much time for seasoning of castings. A short time ago, the writer had occasion to make some special drilling machines that required beds, or cast-iron ways, ten feet long. The contract for making these machines was given to a company that has a reputation for fine tools and special machine work. When the question of seasoning the castings came up, the chief tool designer of this company said that the same effect could be obtained by thoroughly pickling the castings before machining as is obtained when the castings are rough-machined and then allowed to season in the regular way, before being finish-machined and scraped. Is this contention true?

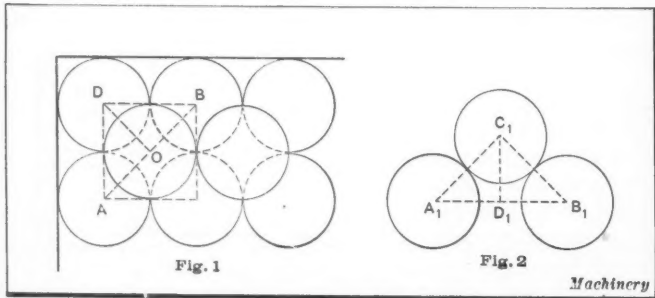
This question is submitted to the readers.

NUMBER OF BALLS THAT CAN BE PLACED IN A CUBICAL BOX

L. A. O.—How many balls, each 1 inch in diameter, can be placed in a box 12 inches by 12 inches by 12 inches, inside measurements?

Answered by J. J. Clark, Scranton, Pa.

A.—If the balls are arranged in layers, as indicated in Figs. 1 and 2, it is evident that $12 \times 12 = 144$ balls will constitute the first layer and $11 \times 11 = 121$ balls, the second layer. The distance between the plane of centers of the first layer and the plane of centers of the second layer is represented by the altitude C_1D_1 of the triangle $A_1C_1B_1$, Fig. 2. The side A_1B_1 is equal to AB , Fig. 1, and as $DA = DB = 1$ inch, $AB = A_1B_1 = \sqrt{1^2 + 1^2} = \sqrt{2}$ inches. $A_1C_1 = B_1C_1 = 1$ inch. Hence, $C_1D_1 = \sqrt{1^2 - (1/2\sqrt{2})^2} = \sqrt{1/2} = 1/2\sqrt{2} = 0.707$ inch. The centers of the first layer of balls must be $1/2$ inch



Figs. 1 and 2. Diagrams for determining Number of Balls that can be placed in a Cubical Box

from the bottom of the box, and the centers of the top layer must be at least this distance from the top of the box. Therefore, the number of layers must be at least equal to $12 - 0.5 - 0.5$

0.707

$= 15$, to the nearest integer. If there are fifteen layers, eight will contain 144 balls each and seven will contain 121 balls each. The distance between the plane of centers of the first layer and the plane of centers of the fifteenth layer is $14 \times 0.707 = 9.898$ inches. The distance from the bottom of the box to the plane tangent to the tops of the balls in the fifteenth layer is $9.898 + 0.5 + 0.5 = 10.898$ inches. Consequently, another layer of 144 balls can be laid on top of the fifteenth layer, thus making nine layers of 144 balls

each and seven layers of 121 balls each. Hence, the total number of balls that can be placed in the box is $9 \times 144 + 7 \times 121 = 2143$ balls.

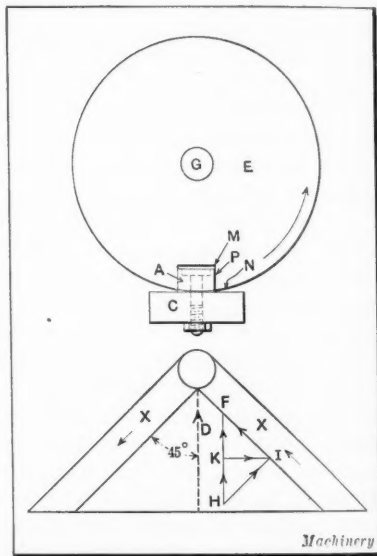
A PROBLEM IN MECHANICS

A. B.—A force of 200 pounds is exerted behind the rod C in the direction D , as indicated, and is transmitted through the roller A to the cylinder E by a groove X cut in the periphery of the cylinder, the angle of which, in respect to line D , is 45 degrees. (1) What per cent, if any, of the 200 pounds will be delivered by the cylinder E at its center G ? (2) How much power must be exerted at G to bring C back to its original starting point? Distance of travel is 16 inches; weight is 20 pounds.

Answered by J. J. Clark, Scranton, Pa.

A.—It is not possible to answer the questions as they stand; not only is insufficient information given, but conditions

that do not exist have been assumed. Let HF represent the force of 200 pounds, and resolve this into two components, one, IF , acting parallel to the groove, and the other, HI , acting perpendicular to the groove. Then, in the triangle HIF , $HI = HF \times \cos 45 \text{ degrees} = 200 \times 1/2\sqrt{2} = 100\sqrt{2}$. Resolving HI into the two components HK , which is parallel to the force D , and KI , which is perpendicular to the force D , $KI = HI \times \sin 45 \text{ degrees} = 100\sqrt{2} \times 1/2\sqrt{2} = 100$ pounds, which is the tangential force acting on the cylinder E in a plane perpendicular to the axis through the center G . It is easy to see that $KI = 100$ pounds, as $KI = HK$ and HK is one-half of HF . Assuming that the point of contact P between the roller and groove is situated one-half the distance between the end M of the roller and the surface N of the cylinder, the moment of the force KI is $100 \times GP$. KI acts only to turn the cylinder, and the turning effect is measured only by its moment; there can be no equivalent force acting at the center G . Hence no force, however large, acting at G will have any effect in producing a movement of the roller as long as there is no lateral movement of the cylinder E .



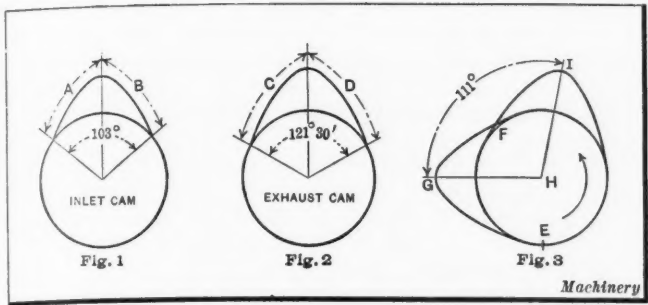
Illustrating a Problem in Mechanics

ANGLE BETWEEN CAMS OF A FOUR-CYLINDER ENGINE

W. M. T.—A four-cylinder engine having a firing order of 1-3-4-2 is so timed that the inlet valve is opened 15 degrees after the upper dead center is past and is closed 41 degrees after the lower dead center is past; the exhaust valve is opened 45 degrees before the lower dead center is passed and is closed 18 degrees after the upper dead center is passed. What should be the size of angles A , B , C , and D , in the accompanying illustration, and also of the angle between the first inlet and first exhaust cams?

Answered by M. V. Terry, Flint, Mich.

In answering this inquiry, certain assumptions must be made, because sufficient information has not been given. The first assumption is that the questions relate to a four-cylinder engine; in this case, the camshaft makes one revolution for every two revolutions of the crankshaft. The inlet valve is



Figs. 1 to 3. Angles of Cams of Four-cylinder Engines

open from 15 degrees past the upper dead center to 41 degrees past the lower dead center, or a total of 206 degrees of the crankshaft circle. The theoretical, or effective, inlet cam angle is, therefore, one-half 206 degrees, or 103 degrees, as shown in Fig. 1. Similarly, as the exhaust valve is open from 45 degrees before the lower dead center until 18 degrees after the upper dead center is passed, it is open for 243 degrees of the crankshaft circle. The theoretical, or effective, exhaust cam angle is, therefore, one-half of 243 degrees, or 121 degrees 30 minutes, as shown in Fig. 2. In most cases, cams are made symmetrical; therefore, angle A = angle B = one-half of 103 degrees, or 51 degrees 30 minutes, and angle C = angle D = one-half of 121 degrees 30 minutes, or 60 degrees 45 minutes.

The actual total angles of the inlet and exhaust cams should be greater than 103 degrees and 121 degrees 30 minutes, respectively, by twice the clearance angle of the cams. The clearance angle depends on the base circle of the cam, the shape and size of the cam follower, and the actual clearance or play, in thousandths of an inch, allowed between the cam follower and the valve. As none of these data are given, it is impossible to calculate the clearance angle, which may vary from 2 to 6 degrees.

As the exhaust stroke of a four-cycle engine immediately precedes the inlet stroke, the exhaust cam leads, or precedes, the inlet cam in the direction of rotation. According to the conditions given, the exhaust valve opening point E, Fig. 3, is 240 degrees (= 45 + 180 + 15 degrees) ahead of the inlet valve opening point F, as measured on the crankshaft circle. This gives an angle of 120 degrees on the crankshaft, which would have been the angle between the center lines of the two cams, were it not that the exhaust cam angle is 18 degrees 30 minutes wider than the inlet cam angle, for 121 degrees 30 minutes — 103 degrees = 18 degrees 30 minutes. The angle between the center lines of the cams is, therefore, 120 degrees minus one-half 18 degrees 30 minutes, or approximately 111 degrees. This is apparent from the construction.

Incidentally it may be pointed out that the practice of opening the inlet valve before the exhaust valve is completely closed, which is known as crossing of valves, is very poor practice. It has been successfully done on some racing engines intended to operate at high speeds only, but on ordinary engines at low speeds crossing results in pre-ignition due to the mixing of the exhaust gases and the fresh charge. In the example given, the crossing of valves amounts to 3 degrees.

TENSION IN A LOADED CABLE

N. A. S.—What is the tension in a cable having a span of 1200 feet when the sag is one-twentieth of the span and the load in the middle is 8 tons? Referring to the illustration, what is the necessary weight W? Is it customary to use a smaller ratio of sag?

Answered by J. J. Clark, Scranton, Pa.

A.—The conditions you give are very unusual, and it may be doubted whether the scheme is practicable. It is impossible to derive a formula that will give exact results, but under

ordinary conditions, the following formula works well in practice:

$$T = L \left(\frac{S}{4H} + \frac{4HL}{S^2W + 2SL} \right) + \frac{S^2W}{8H} + HW$$

in which T = tension, in pounds;
S = span, in feet;
H = sag, in feet;
L = load to be carried, in pounds;
W = weight of rope per foot of length, in pounds.

Since W is unknown, the first step is to reject all terms except the first in the right-hand member of the equation, which

then reduces to $T = \frac{LS}{4H}$. In the present case, $L = 2000 \times$

$8 = 16,000$ pounds, $S = 1200$ feet, and $H = 1200 \div 20 = 60$ feet. Substituting these values in the second expression for T,

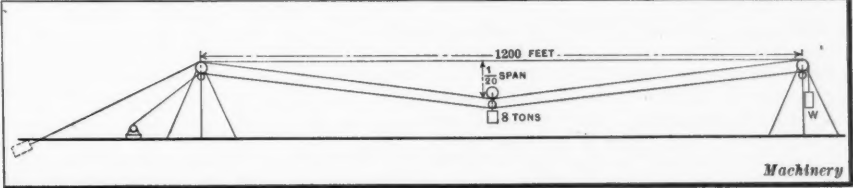
$$T = \frac{16,000 \times 1200}{4 \times 60} = 80,000 \text{ pounds} = 40 \text{ tons.}$$

Referring to page 404 of MACHINERY'S HANDBOOK, a 2 3/4-inch crucible steel wire rope of six strands and a hemp center, with nineteen wires to the strand, has a safe working load of 42.2 tons, with a factor of safety of 5. Such a rope weighs 11.95, say 12, pounds per foot. Substituting 12 for W in the main formula,

$$T = 16,000 \left(\frac{1200}{4 \times 60} + \frac{4 \times 60 \times 16,000}{1200^2 \times 12 + 2 \times 1200 \times 16,000} \right) + \frac{1200^2 \times 12}{8 \times 60} + 60 \times 12 = 117,823 \text{ pounds.}$$

Referring to the second table on page 404 of MACHINERY'S HANDBOOK, the breaking strength of a plow-steel wire rope, 2 3/4 inches in diameter, six strands, nineteen wires to the strand, is 275 tons = 550,000 pounds; its weight is practically the same as the crucible steel

rope. If such a rope is used, the factor of safety is $550,000 \div 117,823 = 4.66$, which is ample for the present case. The weight W equals the tension in the rope, or 117,823 pounds. A sag equal to one-twentieth of

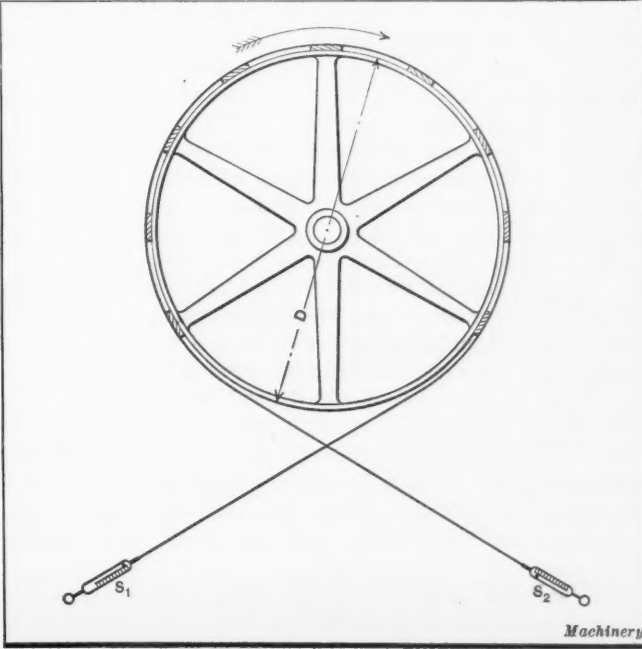


Tension in a Loaded Cable

the span seems to be a reasonable allowance, since the smaller the ratio the greater is the tension in the rope; on the other hand, too much sag would be a disadvantage.

MEASURING HORSEPOWER OF A PULLEY

E. B. J.—The illustration shows an arrangement that has been suggested to us for measuring the horsepower transmitted by a pulley. S₁ and S₂ are spring balances, and increasing or de-



Measuring Horsepower of a Pulley

creasing the distance between them alters the tension in the brake-band encircling the pulley. Please state rule for finding the horsepower. What is the horsepower when S_1 is 14 pounds, S_2 is 238 pounds, diameter of pulley is 8 feet, and the pulley makes 225 revolutions per minute? Does the thickness of the wooden blocks attached to the brake-band have any effect?

Answered by J. J. Clark, Scranton, Pa.

A.—If the force equivalent to the friction between the band and the pulley is represented by F , it is evident that when the pulley is revolving in the direction of the arrow, the pull S_2 must be equal to F plus the pull S_1 ; that is, $S_2 = F + S_1$, or $F = S_2 - S_1 =$ force acting on pulley. This force acts each minute through a distance equivalent to the circumference of the pulley multiplied by the number of revolutions per minute. In other words, the work done on the pulley is $\pi DN(S_2 - S_1)$ foot-pounds per minute, where D is the diameter of the pulley, in feet, and N is the number of revolutions per minute, and this divided by 33,000 gives the horsepower. This must evidently equal the horsepower transmitted by the pulley. Hence, the required formula is:

$$\text{Horsepower} = \frac{\pi DN(S_2 - S_1)}{33,000}$$

Substituting in this formula the values given, we have:

$$\frac{3.1416 \times 8 \times 225 \times (238 - 14)}{33,000} = 38.38 \text{ horsepower}$$

33,000

The thickness of the band or blocks makes no difference, as the friction is applied only to the circumference of the pulley. Further, in so far as the horsepower transmitted is concerned, it makes no difference whether or not a lubricant is used between the blocks and the pulley.

A PROBLEM IN STATICS

E. H. S.—The illustration shows a beam of uniform density throughout, weighing 116 pounds; it is hinged at one end and supported near the other end by a rope attached to an eyebolt, which passes over a sheave L and has a weight X attached to the other end. What weight is required to hold the beam in a horizontal position? What vertical force P is required to keep the beam in the dotted position under the pull of weight X ?

Answered by J. J. Clark, Scranton, Pa.

A.—Neglecting friction and the force due to bending of the rope, the tension T in the rope when the beam is horizontal is equal to the weight X . Let $AF = T$; then, resolving this force into the vertical component V and the horizontal component EF , the force V acting at A is equivalent to a vertical reaction R acting, at H , directly under A . To determine this reaction R , take I as the center of moments; then $R \times 70 =$

$\frac{80}{2} \times W$, or $R \times 70 = 116 \times 40 = 4640$, where W is equal to

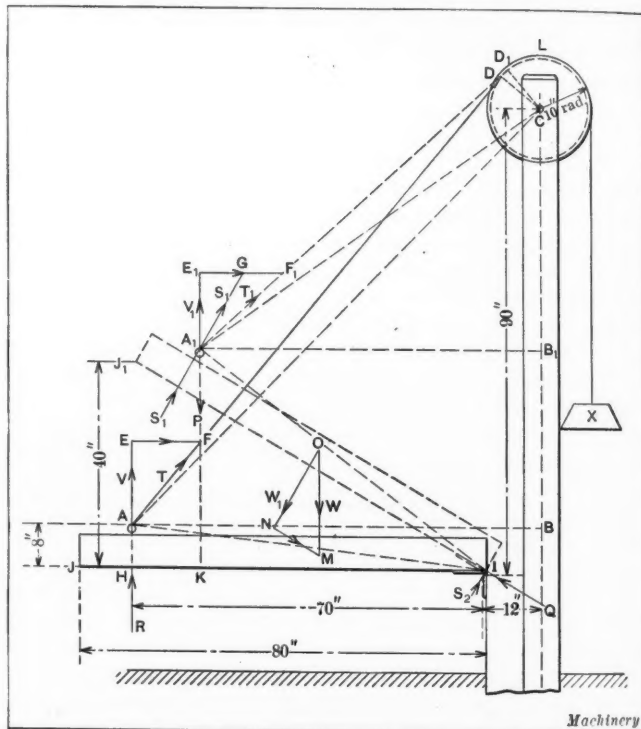
the weight of the beam. Hence, $R = V = 4640 \div 70 = 66 \frac{2}{7}$ pounds. $AB = 70 \div 12 = 82$ inches, and $CB = 90 - 8 = 82$ inches; whence angle $CAB = 45$ degrees, and $CA = 82 \times \sqrt{2} = 115.966$ inches. DAC is the angle the sine of which is $10 \div 115.966 = 4$ degrees 56 minutes 49 seconds, and $DAB = 45$ degrees + 4 degrees 56 minutes 49 seconds = 49 degrees 56 minutes 49 seconds = EFA . Therefore, $T = X = AF = V \div \sin EFA = 66 \frac{2}{7} \div \sin 49$ degrees 56 minutes 49 seconds = 86.597 pounds. When the beam is in the position indicated by the dotted lines, the weight W of the beam, which acts downward at the center O , may be resolved into two components, $ON = W_1$ perpendicular to the beam and NM parallel to the beam. The beam may then be considered as held in equilibrium by the parallel forces S_1 , S_2 and W_1 , and the force Q ; $S_1 + S_2 = W_1$, and Q is parallel and equal, but opposite, to NM . The force P acting in combination with W , the weight of the beam, just balances the weight X ; and $T_1 = A_1F_1 = T = X = 86.597$ pounds. Angle $NOM = JIJ_1$; $W_1 = W \cos NOM = 116 \times 1/2\sqrt{3} = 100.459$ pounds, since $\cos NOM = \cos JIJ_1 =$

$\sqrt{1 - \sin^2 JIJ_1} = \sqrt{1 - \left(\frac{40}{80}\right)^2} = 1/2\sqrt{3}$. Hence, $JIJ_1 = 30$

degrees. Again taking I as the center of moments, $S_1 \times 70 = 100.459 \times 40$, or $S_1 = 57.405$ pounds. Denoting the vertical

component of T_1 by V_1 and of S_1 by $V_2 = S_1 \times \cos (E_1A_1G = NOM) = 57.405 \times 1/2\sqrt{3} = 49.714$ pounds. To find V_1 , it is first necessary to find the angle $E_1F_1A_1 = B_1A_1D_1 = B_1A_1C + CA_1D_1$. Angle $A_1IJ = JIJ_1 + AIH$. $\tan AIH = \frac{8}{70}$, or $AIH =$

6 degrees 31 minutes 11 seconds. $AI = \sqrt{70^2 + 8^2} = 70.456$ inches. In triangle A_1IK , angle $A_1IK = 30$ degrees + 6 degrees 31 minutes 11 seconds = 36 degrees 31 minutes 11 seconds, and $A_1K = 70.456 \times \sin 36$ degrees 31 minutes 11 seconds = 41.928 inches. Also, $KI = 70.456 \times \cos 36$ degrees 31 minutes 11 seconds = 56.623 inches. Whence $B_1C = KC - A_1K = 90 - 41.928 = 48.072$ inches, and $A_1B_1 = 56.623 + 12 = 68.623$ inches. Then, $\tan B_1A_1C = 48.072 \div 68.623$, or $B_1A_1C = 35$ degrees 0 minutes 44 seconds. $A_1C = B_1C \div \sin B_1A_1C = 48.072 \div \sin 35$ degrees 0 minutes 44 seconds = 83.785 inches. $\sin CA_1D_1 = 10 \div 83.785$, or $CA_1D_1 = 6$ degrees 51 minutes 17 seconds. Therefore, $D_1A_1B_1 = E_1F_1A_1 = 35$ degrees 0 minutes 44 seconds + 6 degrees 51 minutes 17 seconds = 41 degrees 52 minutes 1 second, and $V_1 = E_1A_1 = T_1 \times \sin E_1F_1A_1 = 86.597 \times \sin 41$ degrees 52 minutes 1 second = 57.795 pounds. Finally, $P = V_1 - V_2 = 57.795 - 49.714 = 8.081$ pounds. It



A Problem in Statics

will be noticed that the calculation is quite long and that the chances of making mistakes are numerous. A much easier method, and one sufficiently exact for practical purposes, is to calculate V and S_1 and determine all other values graphically.

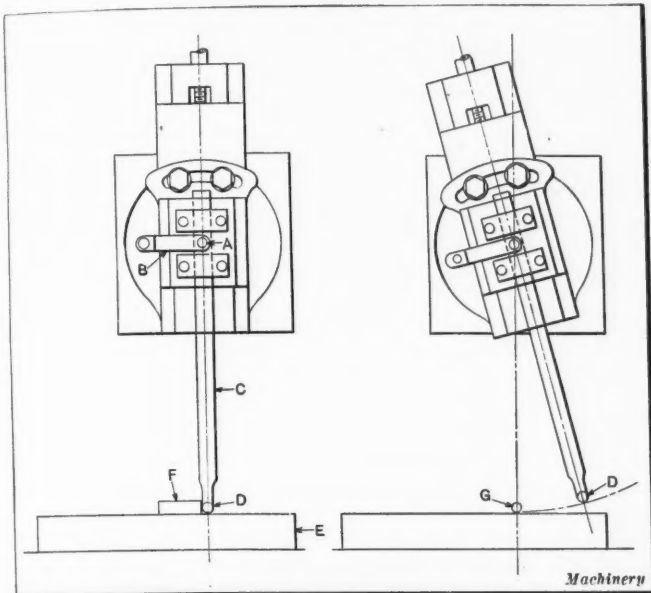
TO GRADUATE A PLANER HEAD WITHOUT SPECIAL APPLIANCES

E. J. R.—Can any reader of MACHINERY suggest a way to graduate the head of a 36-inch planer in a shop where there are no milling machines or graduating machines?

Answered by G. H. G.

One method of graduating a planer head, which is very crude, is to swing the head in a lathe and use a tool held in a toolpost for scribing the graduation lines, and a change-gear on the lead-screw as an index plate. The results are what might be anticipated. Another scheme is to grip the head in a graduated planer chuck. This necessitates locating the axis about which the head revolves in exact coincidence with that of the chuck. This method is preferable to the first one mentioned, but it is far from perfect. A third plan that is sometimes employed is as follows: The head is swung in the lathe, and a point in its axis of rotation is determined by "indicating" the arcs on the head which are to be graduated. Next the head is transferred to an angle-plate, leveled up by its slides and is then turned (plate and all) through 90 degrees.

What is to be the zero point is next located at the height of the center, and, after figuring how far above or below the zero line the other graduation lines should be, the latter are scribed with a height gage. One objectionable feature of this method is that the zero line is located by leveling up from the finished surfaces of the head, which might not be exactly parallel with the vertical travel of the tool-slide. The products obtained by multiplying the radius of the scribed arc by the tangent of the



Method of setting Planer Head for graduating by Application of Sine-bar Principle

angle included between two consecutive graduations has an awkward way of coming out as a mixed number of thousandths, to which it is impossible to set the height gage.

The method recommended is an application of the familiar principle of the sine bar. The revolving part of the head is swung in a lathe and its axis of rotation is brought into coincidence with that of the lathe. A button A, carried by a bracket B, is centrally located relative to the swiveling member. This bracket B is bolted to the "wing", and it is bent so that the projecting end carrying the button is high enough to clear the tool-block. A bar C having at one end of a plug D, $\frac{1}{4}$ inch in diameter, is clamped to the tool-block and so adjusted that the center-to-center distance between A and D is 18 inches. The tool-block should be so set that its center of rotation practically coincides with that of the head. An accurate centering of the tool-block is an advantage, although not absolutely necessary.

The head is now returned to its place on the cross-rail and, before tightening the clamping nuts, it is carefully adjusted until the travel of the tool-slide is vertical with or perpendicular to the planer table, as indicated by the continuous contact of plug D with the blade of a square, the stock of which rests on the table. When this adjustment is made, the head is clamped and the zero graduation line is scribed. The clapper-box is next turned (the head remaining fixed) until the centers of button A and plug D coincide with a line that is perpendicular to the table. The nuts holding the clapper-box are then tightened and the tool-slide readjusted so that the center distance from one button to another is 18 inches. The handle should be removed from the tool-slide feed-screw and the gibs of the slide tightened to insure that there will be no movement of this part during the subsequent operation.

Two parallels E are now laid on the planer table and the cross-rail is lowered until plug D just touches the top of the parallels. Another parallel F is next clamped in a horizontal position across the parallels E and in contact with plug

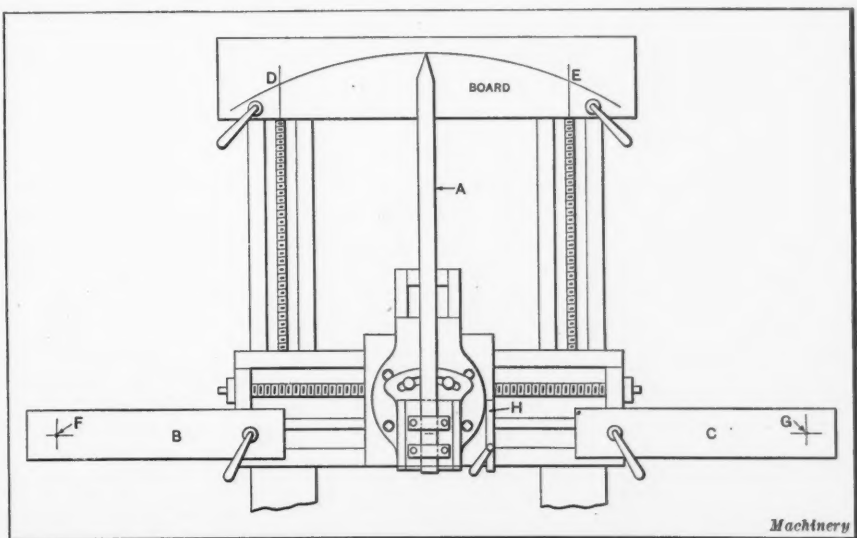
D. The head is now swung slightly to the right, and a plug of the same diameter as D is clamped in contact with the top parallel F. The latter is then removed so that this plug occupies the position illustrated at G in the view to the right, this position corresponding to that of plug D in the view to the left. Everything is now ready for setting the head to the successive angles desired, in order to scribe the graduation marks on the flange. The head is set in each of its angular positions by measuring the distance between plugs G and D with a vernier caliper, the proper distance between their centers for any angle being equal to 36 times the sine of one-half the required angle.

The reason for having plugs G and D of such small diameter is because the setting for the one-degree position could not be obtained with plugs of much larger size. Obviously, when the desired graduations on one side of the zero point have been made, the head can be set by the same method for scribing the graduations on the other side of the zero line. The reason why it is preferable to have the axis of rotation of the clapper-box coincide quite accurately with that of the head is because of the greater accuracy of determining small angles than larger ones by the sine-bar method. Thus, if these two axes were in exact coincidence, it would be possible after graduating, say, 20 degrees, to return plug D to the starting point (by turning the clapper-box backward), the head remaining fixed. The head could then be set with slightly greater accuracy for graduating the angles above 20 degrees.

The work performed by a planer graduated in this way compared favorably with similar work from a planer that was later installed, which had a head graduated by the manufacturers. While it is true that the required distances between the plugs (like those for the height-gage method previously outlined) were fractions to which the caliper could not be set exactly, this was of little importance, owing to the comparatively large radius of the 18-inch sine bar.

Answered by Martin H. Ball, Watervliet, N. Y.

The accompanying illustration shows a method of graduating a planer head by hand, the assumption being that E. J. R. has no dividing head of any kind. The plan is to secure a long bar A having a pointed end as shown, and fasten the opposite end of this bar under the tool clamps. The clapper-box should be wedged to one side to take up any lost motion that it may have, and the head should also be adjusted as closely as possible and still allow it to rotate. Some piece having a surface large enough to scribe a 60-degree arc on,



Graduating a Planer Head by a Direct Transfer Method

such as a smooth well-seasoned close-grained board, is clamped across the upper part of the planer housing as shown. Two smaller boards are clamped at the ends of the cross-rail, as illustrated at B and C. The bar A is used to scribe arc DE and also to scribe arcs F and G. The distance from F to G is transferred by means of trams to some flat surface, such as the top of a planer table, and it is subdivided to find the radius

of arc *DE*. This radius is then used in laying off a 60-degree section *DE* on the board at the upper part of the housing. This 60-degree arc is next divided into 30-degree sections, which are further divided into 15-degree sections, and this work of subdivision is continued until the arc is divided into 1-degree sections. This can be done quite accurately by using small trams and dividers. A small block *H* is clamped to the saddle of the planer head and is used as a guide in scribing the graduation lines, as the end of bar *A* is placed opposite each of the 1-degree divisions. This same method can be used to graduate more than 60 degrees if necessary.

Answered by William C. Betz, New Britain, Conn.

A 36-inch planer head can be graduated in an engine lathe. The lathe must be so geared that the last gear of the indexing train will have 360 teeth passing a given point for each complete revolution of the machine spindle. On a lathe having a simple gear train, with the spindle and the stud gears running equal, or 1 to 1, the following method, illustrated in Fig. 1, may be used:

With a 90-tooth gear on the stud meshing with a 30-tooth gear on the idler, there are three complete revolutions of the idler gear to one revolution of the spindle (any pair of gears with a ratio of 3 to 1 may be substituted); hence it follows that if another gear with 120 teeth is fastened or keyed to the 30-tooth gear, this gear, making three times as many revolutions as the spindle, will have 360 teeth passing a given point at its periphery for each spindle revolution. This would involve two large gears which might not be available, due to the size, so this multiplication of gears may be broken up. Assuming that the spindle gear runs equal with the stud gear, the operation of gearing is as follows: Select any two gears that will run 2 to 1, using for illustration 80 and 40, as in Fig. 2. By placing the 80-tooth gear on the stud and the 40-tooth gear on the idler, the idler gear will run twice as fast as the stud gear. If, now, a 90-tooth gear is placed on the same shaft, keying or otherwise fastening it to the 40-tooth gear, it is evident that twice 90 teeth pass a given point at the periphery of this gear. Now, there are 180 teeth to one revolution of the lathe spindle, and as 360 teeth are required, again multiply 180 by 2, or, in other words, use a gear having half as many teeth, or 45, to mesh with the 90-tooth gear. This again produces a ratio of 2 to 1. If a gear with 90 teeth is fastened to the 45-tooth gear, the result will be twice 180, or 360, teeth passing a given point at the periphery of this last 90-tooth gear of the train.

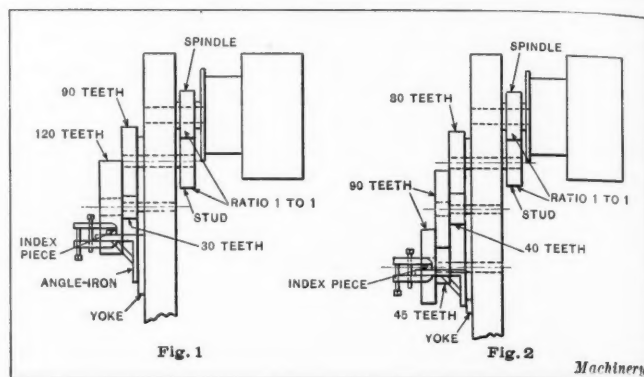
If the lathe is geared 2 to 1, that is, if there are twice as many teeth in the spindle gear as there are in the stud gear, the first example can readily be changed by using a 45-tooth gear on the stud, instead of the 90-tooth gear, and the same results will be obtained. In the second example, two gears of the same size on the stud and idler will also produce 360 teeth. Other combinations of gears can be worked out with the same results by changing the ratios and the gear combinations. In indexing, the spindle should be rotated in one direction only, and a hard wood wedge should be driven lightly between the cone pulley and the lathe head casting to prevent backlash. To index, a small angle-iron is clamped to the idler gear yoke and to this iron an indexing piece shaped to the gear tooth space is fastened with a clamp.

For graduating, the tool-slide of the planer head is removed from the saddle casting and mounted on the lathe faceplate so that the tool-slide center and that of the lathe run true. The graduating tool, preferably one of 60 degrees, is set central with the spindle so that it will cut when the tool-slide is moved from the center toward the periphery of the faceplate and toward the front of the machine. The carriage stop is set to give the tool a certain depth of cut, and the cross-slide is limited by the thread stop to produce marks of a uniform length. After going over the saddle once, the cross-slide stroke should be lengthened a little, every fifth mark made longer to make calculating easier, and every tenth line marked from 0 to 90 on both sides of 0, as it is only necessary to graduate one-half of the saddle.

The saddle should be set so that the lower edge or side

nearest to the platen is at an angle of 90 degrees with the cross-slide and the index piece set in the tooth space in the indexing gear and clamped to the angle-iron. The tool is brought into contact with the saddle and the first line marked; the tool is then moved away, the index piece withdrawn from the tooth space, and the spindle rotated by hand to bring the next tooth space in line with the index piece, which is clamped and the next mark made. This operation is repeated until all the graduations are marked on the saddle.

A witness line is scribed on the tool-slide casting after assembling on the machine by using an indicator and an accu-



Figs. 1 and 2. Gear Combinations for indexing when graduating Planer Head

rate angle-iron. The iron is clamped to the planer platen, and the indicator clamped in the toolpost and brought into contact with the iron. The indicator is worked up and down by means of the tool-slide and screw until the slide is adjusted to a vertical plane and until the indicator shows no movement of the needle. The witness lines may then be scribed and marked 0 on both sides of the slide.

* * *

COST PLUS TEN PER CENT

As a result of the publication of an editorial entitled "Cost Plus Ten Per Cent" in the January number of *MACHINERY*, a communication has been received from the Ferro-Concrete Construction Co., Cincinnati, Ohio, stating that for several years this company has done building work on a "Profit Sharing" or "Cost-Plus-Fixed-Sum" form of contract, similar to that suggested, and that most of the present business is now on that basis. The details of the contracts vary with the nature of the work, but the following example will illustrate the general features: After describing the work to be performed, the contract reads:

The owner shall pay the contractor the actual cost of the work plus a fixed sum of \$10,000. It is agreed that in case the total cost, including the fixed sum mentioned above, is more than \$102,660, fifty per cent of such excess cost shall be paid by the owner and fifty per cent by the contractor; provided, that the total cost to the owner, for the work covered by this contract, and exclusive of authorized extras, shall in no case exceed \$107,660. It is further agreed that in case the total cost, including the fixed sum mentioned above, is less than \$102,660, fifty per cent of the saving shall be added to the contractor's fixed sum.

Of course the great advantage of such a form of contract is the mutuality of interest, but it has other advantages for the owner in protecting him against excessive charges for extras and in permitting him to make an advantageous contract before detailed plans are completely developed.

* * *

The War Trade Board has decided that goods placed alongside a vessel, but not loaded upon it, are delivered. Frequently shipments arrive alongside a steamer before the export license has expired, but, owing to the inability of the steamer to load the contents of the lighter promptly, the shipment is held until the license expires. In order not to cause any unnecessary inconvenience to shippers and to help in avoiding any congestion that might be due to shipments of this kind, the Bureau has ruled that the time of the arrival of the lighter alongside of the ocean-going vessel or steamship dock will be the deciding factor should any dispute arise as to the validity of the license.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

IN THIS NUMBER

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METALWOOD HYDRAULIC SHELL-TESTING PRESS

THE hydraulic shell-testing press to be described is used in connection with tests for determining whether heat-treated shells have the elastic limit required by specifications and are free from forging defects or piping through the base. The inside of the shell is subjected to hydrostatic pressure, and any permanent set or increase in shell diameter over the specified allowance indicates that the elastic limit is too low. This press is the product of the Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich. The size shown is designed primarily for shells known as the "75-millimeter high-explosive projectile Mark I." The shell to be tested is first filled with water and then is securely held between the upper clamping ram of the press and a lower member, against which the nose of the shell bears.

Fig. 1 is a view of the press; Fig. 2 shows a detailed view of the top part; and the front and side elevations shown in Fig. 3 illustrate the general arrangement. There is an intensifying cylinder of correct proportions and a pull-back cylinder under constant line pressure to build up the required internal test pressure within the shell and resistance head. A cylinder of the proper size also exerts an excess over pressure between the shell nose and resistance head beneath the shell which has a fluid-tight joint. This press is guaranteed to deliver a maximum intensified pressure within the shell chamber of 18,500 pounds per square inch, with variations down to a minimum pressure of 2000 pounds per square inch.

The sealing pressure exerted by the upper clamping cylinder is approximately 50 per cent in excess of the opposing intensified pressure. The arrangement is such that the objectionable pre-filling and emptying of shells outside of the machine is dispensed with. The shell is filled by immersion in the tank, which is clearly shown in Fig. 2. The shell is held in an inverted position or with the open end downward. When held in this way, there can be no uncertainty or difficulty due to confusing "water sweat" resulting from porosity, with a leakage or drip through a defective seal or joint, as when the open end or nose is at the top. In order to avoid any confusion or mistakes of this kind, the shell is placed in the inverted position as explained. The objectionable trapping of air within the shell is avoided, since all parts of the high-pressure head remain under water and all displacement due to the intensifying ram takes place beneath the water column. Absolute fluid pressure readings are obtained only by the elimination of such air pockets within the shell or gage ducts.

The clamping pressure has been carefully calculated to avoid any undue column stress on the shell structure. The detailed view, Fig. 4, shows the method which has proved successful for making the sealed joint at the open end or nose of the shell when the intensified ram pressure is applied within the shell chamber. The hardened tool-steel ring A has a V-shaped annular bead or ridge that engages the end of the shell; the latter, in turn, is held downward by the over-pressure from

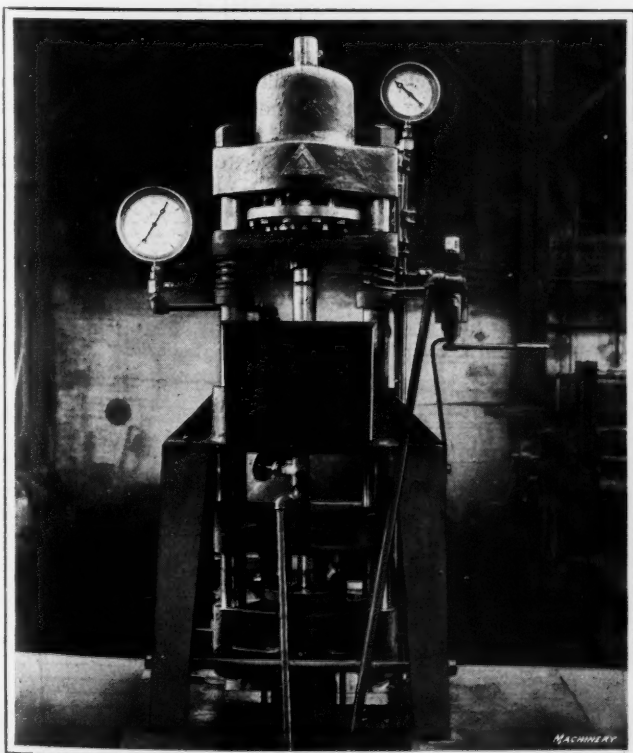


Fig. 1. Metalwood Hydraulic Shell-testing Press

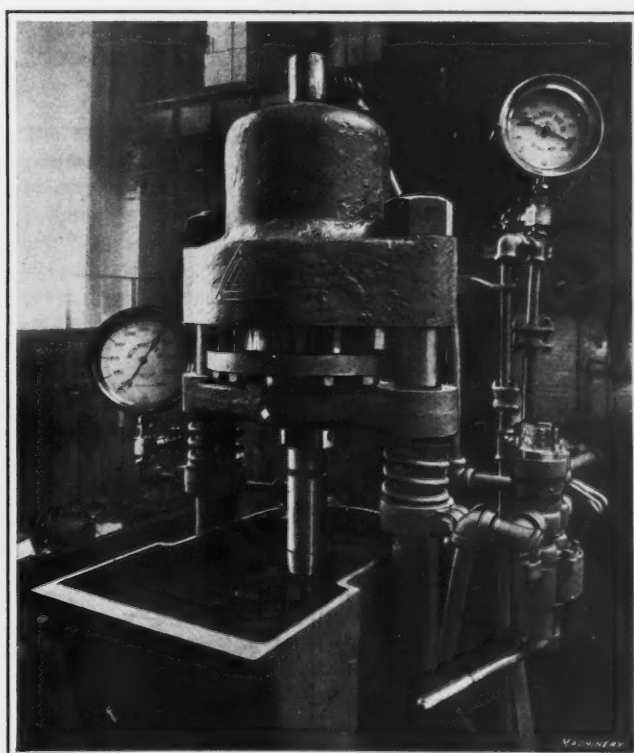


Fig. 2. Upper Part of Shell-testing Press

the clamping ram above. This pressure is partially balanced by the intensified column pressure due to the area within the sealing ring. Beneath ring A, which is supported by the high-pressure head C, there is a copper gasket B, which makes a tight joint between the high-pressure head C and ring A. The nose of the shell is centered by ring D. The plunger E or the intensifier ram, as the result of hydrostatic pressure of the lower cylinder, causes the built-up pressure within the shell chamber.

The standard equipment consists of a complete plant, which is installed where no hydraulic power is available. This plant includes the internal test press referred to; a triplex single-acting pump; a multiple-yoke type of accumulator; and a positive-control by-pass valve to release excess pump delivery. When testing a shell the pressure should be applied for a period of fifteen seconds, according to the Ordnance Department specifications, and then the capacity of the press is over two shells per minute, or an average of 800 to 1000 shells for a ten-hour period. The absolute rate of production depends upon the ability of the operators to handle the shells in placing them in and removing them from the press. The displacement of water due to one operating stroke of the press is 0.6 gallon.

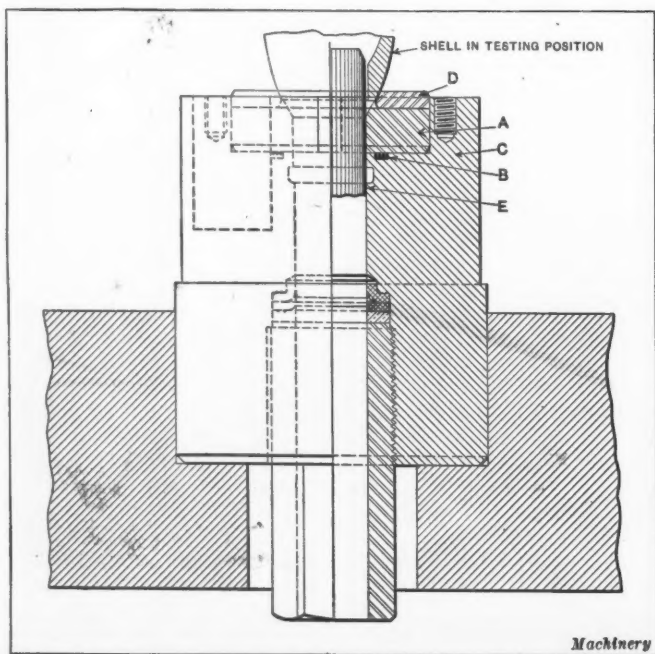


Fig. 4. Method of sealing joint at nose or open end of shell

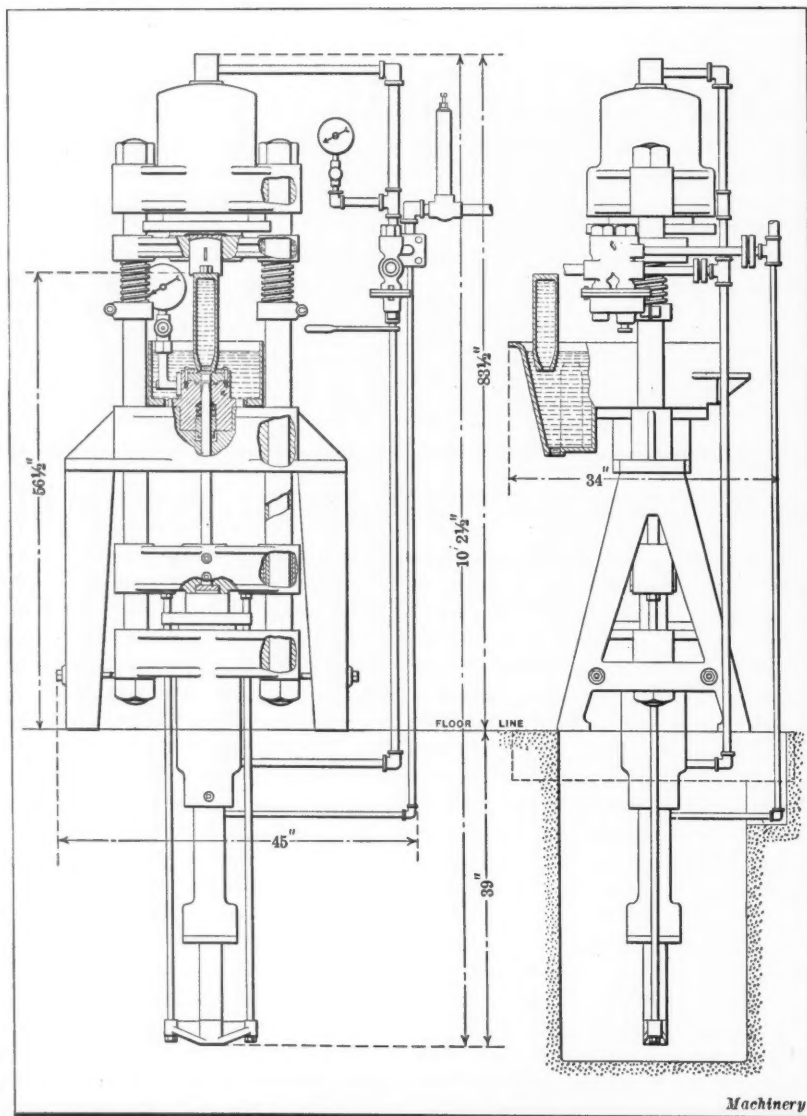


Fig. 3. Front and Side Elevations of Shell-testing Press

partment specifications, the Metalwood Mfg. Co. also builds a No. 2 press which will test 4.7-inch shells and corresponding 5-inch sizes, and also a No. 3 press having a testing capacity for 155-millimeter shells and 6-inch gun and howitzer shells (Mark I and II). The handling of shells corresponding to the 3-inch and 75-millimeter sizes is accomplished manually where the average 10-pound weight is well within the capacity of the operator. The 6-inch and 155-millimeter shells are conveyed by a light differential hoist and monorail carriage. The filling and emptying of the shells with water is manipulated by a segment clamp trunnion provided with an offset hand-fulcrum. The method of handling 155-millimeter shells with this device is illustrated by the views shown in Fig. 5.

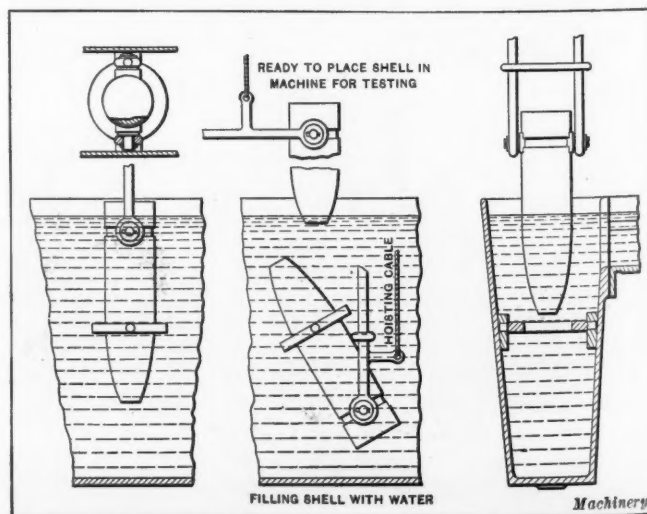
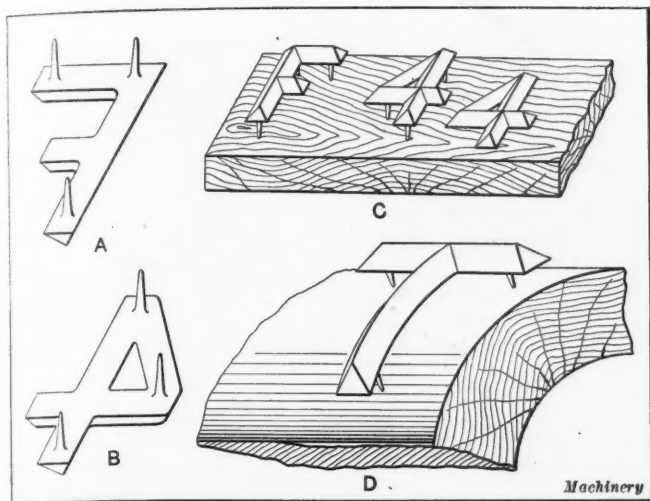


Fig. 5. Method of handling 155-millimeter shells

The working cylinders are alloy steel castings having polished bores; they are tested to 3000 pounds per square inch. The pull-back cylinder is a steel casting; the lower and upper main rams are 40 per cent semi-steel, ground and polished; the intensifier plunger is of tool steel, hardened and ground; and the cross-head carrying the intensifier shell plunger is a semi-steel casting with bronze bearings. The main packings consist of boxes and glands suitable for square hemp, or, preferably, hydraulic packing. The resistance head is provided with packings suitable for fluid-tight pressures ranging up to 18,500 pounds per square inch maximum. The machine has a cast-iron base and a cast-iron pre-filling tank.

In addition to the No. 1 size of press described in the foregoing, which has a capacity for all 3-inch common steel shells as well as the 75-millimeter size within the de-



Maughlin Pattern Letters and Method of applying to Flat and Curved Surfaces

MAUGHLIN PATTERN LETTERS

The H. P. Maughlin Co., Columbus, Ohio, has placed on the market a pattern letter having a number of points on the under side, so that it can be attached permanently to a pattern. These letters are made of a hard aluminum alloy to withstand severe usage and prevent the surface from being marred, as, for example, when they are being driven into the pattern or in case they come into contact with the molders.

chuck (see right-hand view). The body of this chuck is formed of two principal parts, namely, the housing *A* and the back-plate *B*. These parts, after being machined, are forced together and held by screws. The housing may be either a steel or a semi-steel casting, as desired, and it is designed and proportioned to give ample strength at those points where experience has proved that strength is required. The back-plate is fitted to the finished surface inside the housing. The spindle faceplate is fastened to the chuck back-plate by three screws *C*, which extend through the chuck body as shown. These bolts, in conjunction with the shoulder *D* on the chuck, which fits into a corresponding recess in the faceplate, hold the chuck securely in position and provide a rigid construction.

Each jaw connects with a sector *E*, which, in turn, is engaged by a cam bushing *F* attached to the draw-rod spindle *G*, the latter extending to the air cylinder that operates the chuck. A sectional view taken through the pin on which sector *E* swivels is shown in Fig. 2. This illustration also shows the arrangement of the chuck jaw and its slide. There is no open space around the inner part of the chuck-jaw slide, which has a rigid backing. The jaw slide *N* throughout its entire length rests on both the milled tongue in the wall of the chuck housing and the milled seat in the back-plate; as the latter extends to the hole in the center of the chuck, the jaw slide has a complete bearing when the chuck jaw is set at different positions. These jaws are reversible, and master slides for false and special jaws can be furnished. The arrangement of the jaw slide for holding the chuck-jaw adjusting screw for independent movement is a noteworthy feature. The jaw slide is

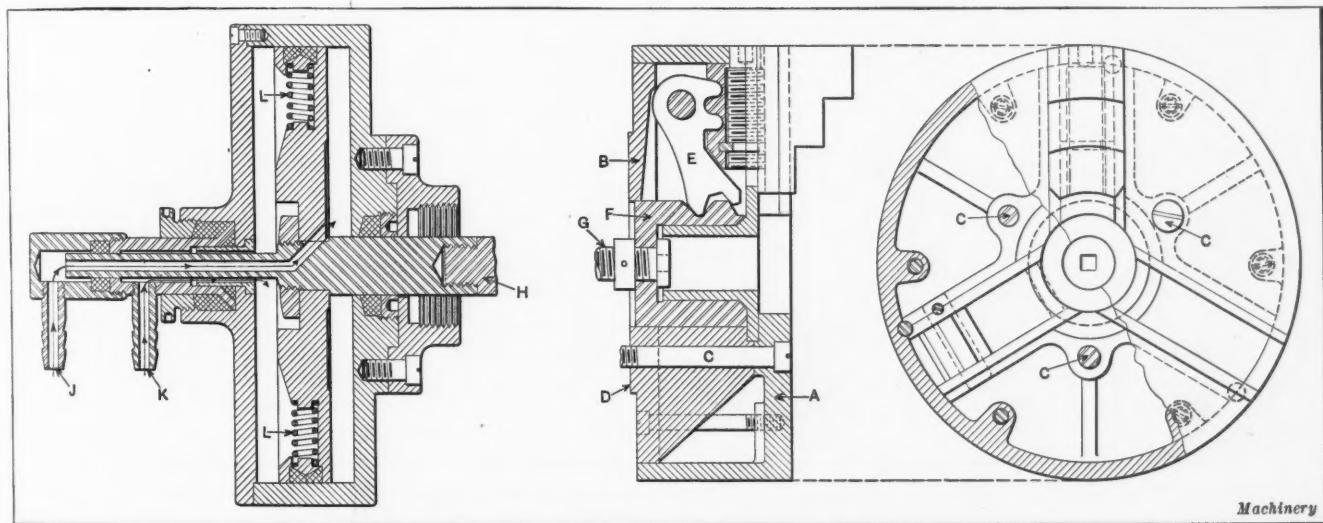


Fig. 1. American Double-acting Air Cylinder and Three-jaw Universal Chuck

vent wire. The points are of even length and the letters or figures can be located temporarily while determining the proper arrangement, alignment, spacing, etc., either on flat or curved surfaces.

The under side of a letter and a figure are shown at *A* and *B* in the accompanying illustration. The method of applying letters and numbers to a pattern is illustrated at *C*, one figure being shown as permanently attached. The lower view *D* shows how a letter can be applied to a curved surface. The points that are driven into the pattern are so located that they hold all parts of the letter or figure firmly in contact with the pattern surface. When attaching a number of letters or figures at a time, they may be slightly pressed into the pattern with the fingers after being properly aligned; then a blow from a hammer will serve to drive one or more letters at a time without dislodging the rest.

AMERICAN AIR-OPERATED CHUCK

An air-operated chuck to be known as the "American" has recently been placed on the market by the American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill. This chuck has been designed along the lines of a standard combination lathe chuck having the universal and independent operating features. Fig. 1 shows a cross-sectional view of the three-jaw

in the back-plate only and does not project through into the chuck housing. The adjusting screw has bearings at both ends of the slide, so that it is solidly and rigidly supported.

The double-acting air cylinder used in conjunction with this chuck is illustrated at the left in Fig. 1. This air cylinder is attached to the rear end of the machine spindle, and it is connected to the chuck by draw-rod *H*, which extends through the hollow spindle and is screwed onto the threaded end of rod *G*, Fig. 1. This is a 10-inch cylinder having a stroke of 1 inch. The air inlets are located at *J* and *K*. The piston is provided with self-contained springs *L* to keep the piston packing against the surface of the spindle and eliminate hand adjustment as well as leakage, so that the full air pressure is utilized and the air consumption reduced to a minimum. The design is such that all parts re-

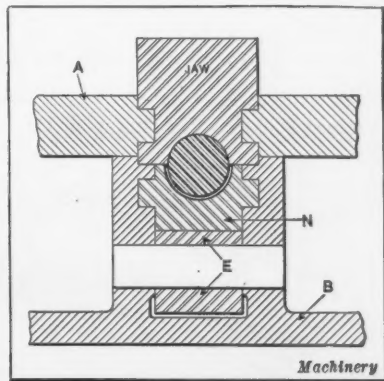
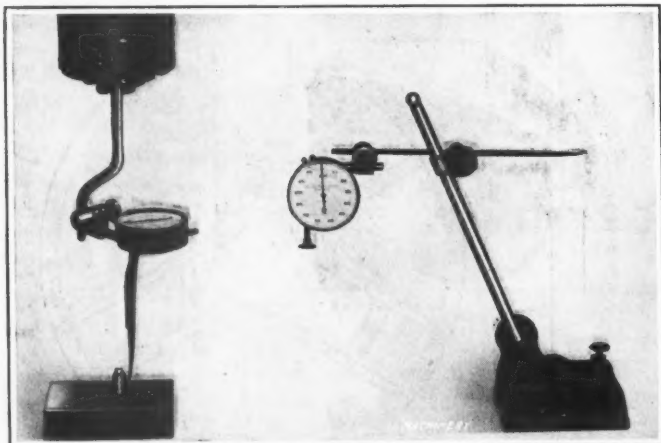


Fig. 2. Section through Chuck Jaw on Line with Center of Sector Pin

quiring packing are easy of access. When air is admitted to the cylinder, cam bushing *F* (Fig. 1) is drawn back and, as sector levers *E* travel with it, they operate the three jaws universally. The gripping power due to the 3 to 1 leverage of the sectors is considerably increased by the wedging action of the cam surfaces acting upon the ends of the levers. When the chuck jaws are properly adjusted for a given diameter of work, each sector lever is forced up the face of the cam until it reaches the straight surface of the cam bushing, when the jaws are locked upon the work and the latter is held firmly, even though the air pressure may be released. The chuck has been so designed that if it is not desired to operate it pneumatically, the air mechanism can be locked and the chuck used as an independent hand-operated type. This style of chuck is also made in the two-jaw design, which is operated in the same way as the three-jaw type. Both designs are made in standard sizes of 6½ inches, 8 inches, 10 inches, 12 inches, and 15 inches in diameter. The Neidow & Payson Co., 9 S. Clinton St., Chicago, Ill., is the selling agent for the American Pneumatic Chuck Co.'s products.

GATES DIAL INDICATOR

The dial indicator which is made by B. L. Gates, 125 S. Wells St., Chicago, Ill., is intended for setting up work on machines and for the other purposes which indicators of this class are generally used for. This indicator is so arranged that the dial is always visible to the workman, so that it is unnecessary to walk around a machine when setting a jig



Gates Dial Indicator applied to Machine Spindle and to Surface Gage

button or other part in alignment with a spindle to which the indicator is attached. The view to the left in the accompanying illustration shows the position of the dial while it is being used for truing a button. As the dial is in a horizontal position, it remains visible as the spindle revolves and a looking glass is not required to show variations in the movement of the indicating hand. The dial is graduated to read to thousandths inch, the graduation figures giving a direct reading up to 0.130 inch. This indicator may, of course, be applied to a surface gage as the illustration shows, or it may be used in conjunction with limit gages and other forms of measuring tools.

COOPER UNIVERSAL JOINT

The universal joint shown in Fig. 1 is manufactured by the Cooper Flexible Transmission Co., Inc., 8th Ave. and 18th St., Brooklyn, N. Y.

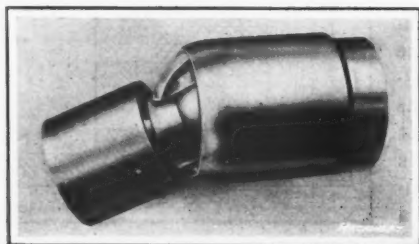


Fig. 1. Cooper Universal Joint

This joint was designed for the general machine trade, and it is manufactured in various stock sizes. There are no sharp corners or projections on this joint, and the parts are all

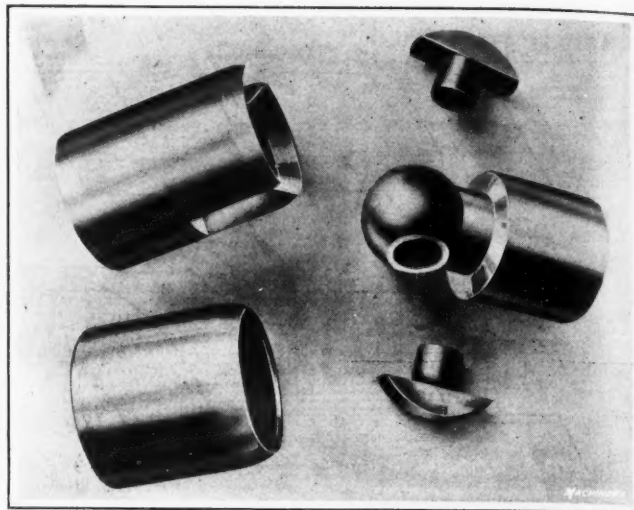


Fig. 2. Component Parts of Cooper Universal Joint

concentric with the shaft. The construction will be more apparent by referring to Fig. 2. The drive from the ball to the socket is by means of two "cross-heads," each of which has a pin which fits into a hole extending through the ball. The main purpose of these pins is to guide the cross-heads and to keep them central. These pins are subjected to some load, but the main drive between the ball and cross-heads is where the flat under side of each cross-head rests on the face at the side of the ball. The cross-heads engage the slots in the socket when the joint is assembled.

One half of the ball is engaged by the socket at all angles, which allows for any thrust that may be encountered. The cross-heads are subjected only to the torsional stresses, so that the thrust is transmitted directly from the ball to the socket, there being no intermediate parts to be strained. The four parts of the joint are held in position by an outer shell, which is forced into place after assembling the joint, and no screws or rivets enter into the construction. The outer sleeve is secured by pressing the end into a groove previously turned in the socket member. This construction enables the joint to resist any tension ordinarily encountered. The most important function of the outer shell is the forming of an oil receptacle to insure adequate lubrication when the joint is in a vertical position or inclined from the horizontal. All wearing parts are heat-treated and casehardened by the most approved methods. The angle is limited to 30 degrees, as it has been found by experiment that any angle exceeding 30 degrees causes absorption of power and wear out of all proportion to the results obtained.

HEINKEL GEARLESS MULTIPLE-SPINDLE DRILLING HEADS

Multiple-spindle drilling heads of the gearless type, as shown in Figs. 1 to 3, inclusive, are now being manufactured by the

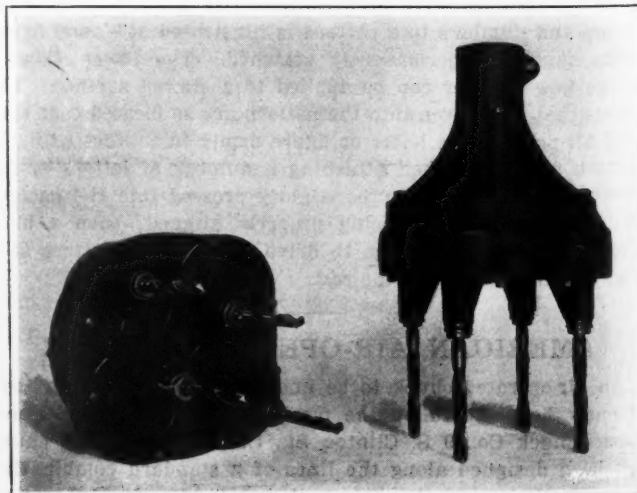


Fig. 1. Heinkel Four-spindle Adjustable Drilling Head

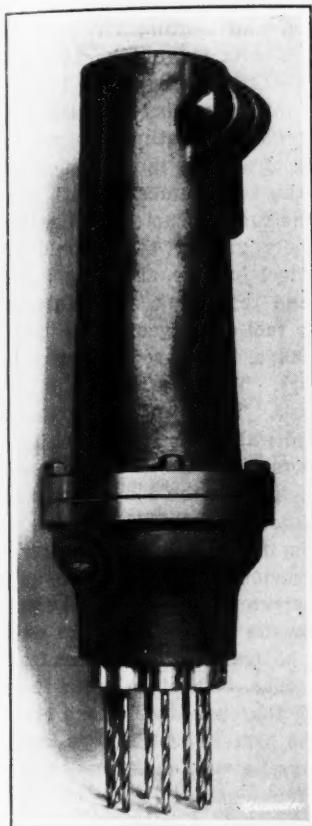


Fig. 2. Eight-spindle Drilling Head of Fixed-center Type

from the machine spindle is through the hardened and ground taper shank *D*, which has a crank on the lower end. This crank has an annular ball bearing *E* mounted on it. Bearing *E* is contained within the driving plate *F*, which is carried around or oscillates when the taper shank revolves. The hardened and ground steel bushings *G* are inserted in the driving plate *F*, and the hardened and ground cranks *H* are a running fit in these bushings. The spindles *J* on which cranks *H* are formed are provided with a bronze bearing *K* and also an

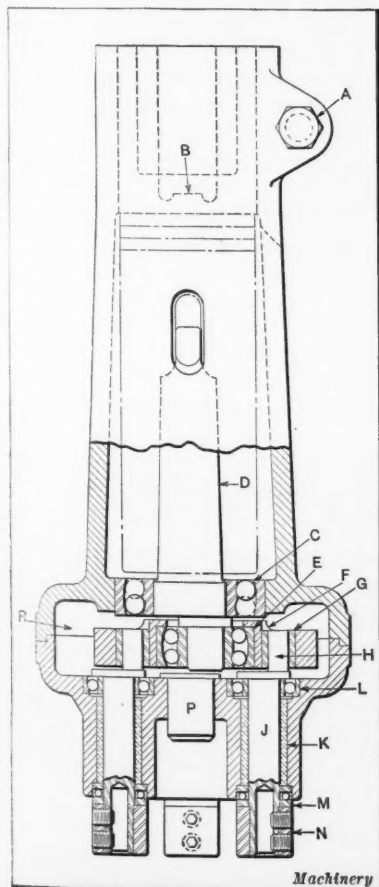


Fig. 3. Sectional View of Drill Head

Heinkel Machine Tool Co., Sandusky, Ohio. Fig. 1 shows two views of a four-spindle drilling head of the adjustable type. The spindles may be adjusted to any center distance within the range of the head while the machine is running, so that the operator has a better opportunity for accurately locating the drills in jig bushings. When this head is adjusted, it may be locked rigidly in position.

Fig. 2 shows an eight-spindle drilling head of the fixed-center type. This design is intended for drilling large numbers of duplicate parts. The construction of the fixed-center type is illustrated by the sectional view in Fig. 3. The head is fastened to the sleeve or quill of the drilling machine by clamp screw *A*, and it is prevented from slipping upward under the drilling strain by stop *B*, which bears against the bottom of the rack. The annular ball bearing *C* provides extra support for the head and the drill press spindle. The drive

from the machine spindle is through the hardened and ground taper shank *D*, which has a crank on the lower end. This crank has an annular ball bearing *E* mounted on it. Bearing *E* is contained within the driving plate *F*, which is carried around or oscillates when the taper shank revolves. The hardened and ground steel bushings *G* are inserted in the driving plate *F*, and the hardened and ground cranks *H* are a running fit in these bushings. The spindles *J* on which cranks *H* are formed are provided with a bronze bearing *K* and also an annular ball bearing *L*. In addition, a ball thrust bearing *M* is mounted on each spindle and is locked in place with the proper degree of end clearance by the nut *N*, which cannot slip and cause tightening of the thrust bearings. The oscillating motion of the driving plate *F*, resulting from the rotation of the crank on taper shank *D*, causes spindles *J* to revolve, the driving plate serving practically the same purpose as a connecting-rod. The hardened steel plug *P* is used for driving the taper shank tight into the drilling machine spindle.

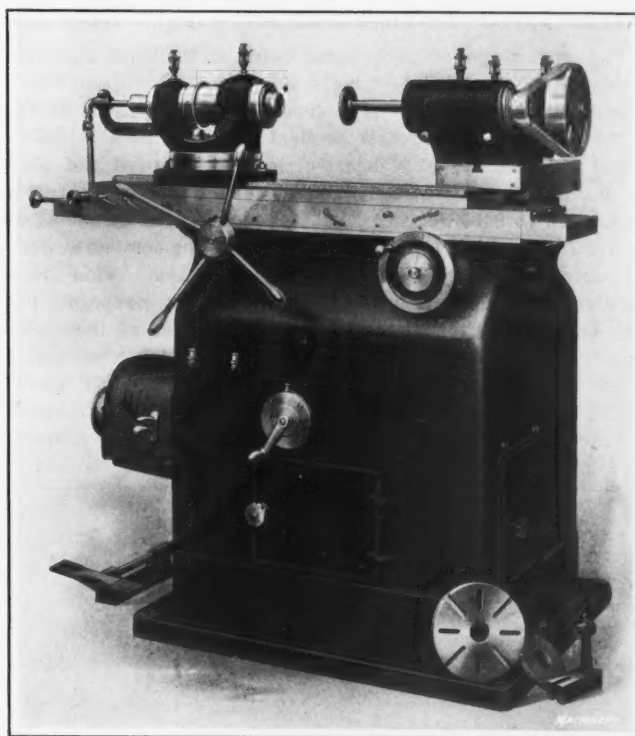
The head is oil-tight and entirely enclosed to prevent the entrance of dirt or dust. It is packed with grease in chamber *R* and needs only occasional attention from the operator, as, for example, when chamber *R* needs refill-

ing. The lubrication is automatic, as the ball bearings *L* convey grease from the chamber to the bronze bearings *K*, which are provided with oil-grooves. These grooves, in turn, allow sufficient lubricant to pass down to the thrust bearings. This drilling head was made as simple in design and construction as possible, in order to eliminate the breaking of parts and reduce the wear and upkeep expense to a minimum. The claim made for the crank method of driving is that it is absolutely positive; eliminates gears entirely; provides for closer center distances, quiet operation, lighter and smaller heads, both in over-all length and diameter, and a smaller loss of driving power through bearing friction.

RIVETT NO. 106 INTERNAL GRINDER

The Rivett Lathe & Grinder Co., 20 Riverview Road, Brighton, Boston, Mass., is now manufacturing a heavy-duty large capacity internal grinding machine which is designed along the same general lines as the No. 103 internal grinder. The new machine is known as the "No. 106 automatic internal grinder," and it is suitable for manufacturing purposes where the work is comparatively heavy and the amount of metal to be removed above the average. This grinder is also particularly adapted for precision work in the tool-room or experimental department, as the necessary adjustments for handling a large variety of work can be made readily.

This machine is driven by four belts, which are used to drive the wheel-spindle, the work-carrying head, the internal mech-



Rivett No. 106 Internal Grinder designed for Heavy Duty and for Manufacturing Purposes

anism of the machine, and the water pump. The main belt connects with a three-step cone pulley, which, in conjunction with a set of change-gears having six combinations, gives a variety of eighteen speeds for the work-carrying table. The reciprocating motion of the table is derived from a heart-shaped cam which gives a variable rate of travel with a maximum at both ends of the stroke and a minimum at the center. The object of this varying rate of travel is to overcome any tendency of the machine to grind holes bell-mouthed. The wheel-spindle is carried by a heavy bracket, which is adjustable for position on a cross-slide, and this is mounted on a cross-slide table. This bracket also carries the wheel-spindle countershaft. The proper belt tension is maintained by a self-adjusting belt tightener.

The grinding wheel may be adjusted for depth of cut either by hand or by the automatic cross-feed mechanism. Both the grinding wheel and the countershaft spindles are provided with ball bearings, so that they are suitable for high speed

operation. The work-carrying head is mounted on a sliding shoe and arranged to swivel up to 90 degrees. This head is driven direct from a drum on the overhead countershaft. The spindle construction is exceptionally heavy, and adjustable taper steel bearings are provided. Rivett chucks of the collet or step types may be used in addition to a faceplate or chuck-plate for holding either a standard three- or four-jaw chuck or some special chucking fixture.

The length of the stroke of the work-carrying table is regulated by means of a crank on the front of the base, which provides stroke adjustments varying from 1/4 to 8 inches. To facilitate measuring or gaging the work, the table may be disconnected at any time from the reciprocating mechanism and be returned to its original position without interfering with any adjustment. The grinder is provided with a rack and pinion, and is equipped with a pilot wheel for rapid movements of the work-table. This machine will swing a diameter of 14 1/2 inches over the table, and it has a grinding capacity for diameters varying from 1/4 to 8 inches. The net weight of the machine is 3000 pounds. The regular standard equipment includes a complete water attachment, an overhead ball bearing countershaft, a heavy work-head or wheel-spindle with three arbors, a light work-head or wheel-spindle with three arbors, a bracket for a diamond holder, a 5-inch chuck-plate, six canvas belts for the wheel-spindle, and a gallon can of special spindle oil.

TRIAD COMBINATION HARDENING, PRE-HEATING AND TEMPERING FURNACE

The advantage of preheating both carbon and high-speed steels is constantly being more generally recognized both in this country and abroad. The general method of treating high-speed steel tools is to first preheat the steel in a furnace to about 1500 degrees F. The steel is then removed and placed in another furnace already heated to a temperature varying from 2200 to 2350 degrees F. The steel is next quenched and cooled from a high temperature and then the temper is drawn by means of an oil bath, lead bath, or dry heat. This process requires the installation and operation of three separate heating units, and even though the primary cost of installation is not considered, the extra cost for the fuel consumed by these three units is an item which should not be ignored.

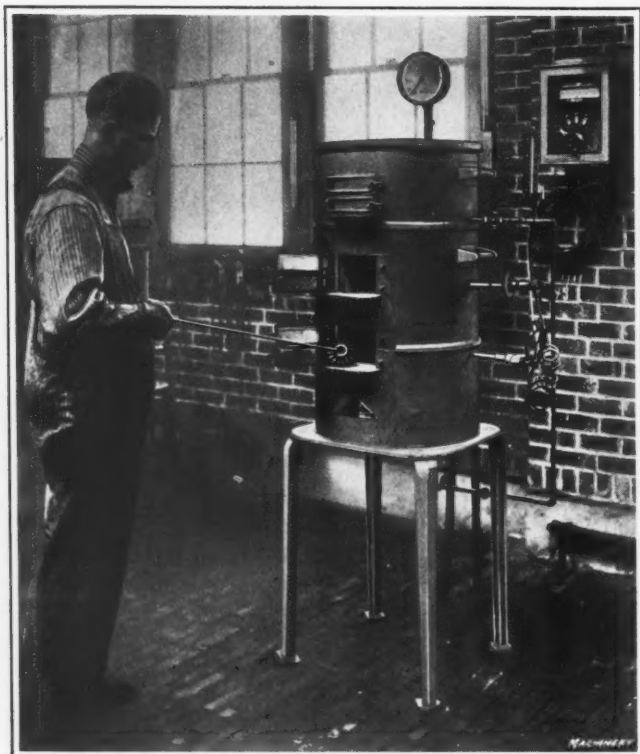
The Triad furnace, which has been developed and placed on the market by the Bennett Metal Treating Co., Elmwood,

Conn., serves a threefold purpose in that it is adapted for preheating, high-temperature heating, and heating for drawing the temper. This furnace operates with but one burner, and is so constructed that the three heating processes can be carried on simultaneously. It has three chambers located one above the other. The high-temperature heating is done in the lower chamber, the preheating of steel in the intermediate chamber, and the tempering in the top chamber. With this arrangement, it is claimed that the fuel consumed for heating all three compartments is scarcely greater than would be required for a single high-speed steel furnace, since the waste heat is utilized for preheating and tempering. The furnace operates satisfactorily with either fuel oil or gas.

The furnace is cylindrical in shape, to insure uniform temperatures and obviate cold corners. The interior of the furnace is about 12 inches in diameter. The lower compartment has a base brick and a double-lined wall of firebrick, each having a thickness of 4 inches. The intermediate chamber is approximately the same shape and size as the lower one, and has top and bottom slabs and insulating walls, which are also 4 inches thick. This chamber is intended for temperatures up to 1500 degrees F. and, as previously mentioned, is used for preheating. One important advantage in having the preheating compartment so close to the high-temperature compartment is that the work may be transferred quickly from one part of the furnace to the other without injuring it by oxidation. The heat arising from the open door of the lower compartment serves to protect the heated steel as it is transferred from the intermediate or preheating chamber down to the lower one.

The bottom of the upper or tempering chamber consists of a steel plate located one inch above the top firebrick slab of the intermediate chamber. The excess heat from the preheating chamber passes through the upper slab and heats the plate referred to. As the excess heat is frequently greater than is required for tempering, this is regulated by a valve and mercury air gage. It is claimed that sufficient heat for hardening tool steel can be obtained in the lower compartment of this furnace in ten minutes from the time the cold furnace is started. The time specified for obtaining a hardening heat for high-speed steel from a cold start is twenty minutes. When heating a 3- by 3/4-inch milling cutter, the time required to increase the temperature from a preheat of 1500 degrees F. to 2250 degrees F. is two minutes, thirty seconds.

According to the manufacturer, steel may be heated in either the intermediate or lower chamber under absolutely reducing atmospheric conditions, thus preventing pitting or scaling. The temperatures in both the intermediate and lower compartments are determined by a pyrometer. The drawing temperature in the top compartment is indicated by a thermometer. As the illustration shows, the two upper sections of the furnace are equipped with handles. These are provided so that if the lining of the lower compartment should require repair or renewal, the upper sections may readily be removed without waiting for the furnace to cool. The doors of the different compartments are in sections, so that a narrow or wide opening may be obtained, according to the requirements. The weight of the furnace complete is 750 pounds.



Triad Furnace which is adapted for Preheating, High-temperature Heating, and Heating for drawing Temper

NEW MACHINERY AND TOOLS NOTES

Taper Gage: Davie Tool Co., Cleveland, Ohio. Taper plugs, etc., can be tested with this gage, which has a V-block mounted on the base and an adjustable blade above the center of the V-block, which is held in the required position by means of two knurled nuts. This gage is made in various sizes, and also with stops to indicate the proper length of taper.

Quick-acting Vise: Nestor Mfg. Co., 40 W. 13th St., New York City. Vise which may be applied to drilling or milling machines or to the faceplate of a lathe. It is made in three sizes, the smallest of which has a maximum opening of 2 1/2 inches, and the largest, a maximum opening of 6 inches. Flanges extending around the sides and end are machined square, so that the vise may be held on either the side or end if desired.

Pipe Vise: Gerolo Mfg. Co., Old Colony Bldg., Chicago, Ill. Portable pipe vise which can be mounted readily wherever

required on any kind of a horizontal or vertical support and without the use of bolts. Any size of pipe or conduit within the capacity of the vise is securely held by the slight push of a lever, no previous adjustment being necessary. The pipe is gripped between a double set of steel pipe jaws and a heavy close-linked steel chain.

Magnetic Brake: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mill and hoist motor magnetic brake made in two styles for alternating and direct-current motors. The construction of the two types is similar except for the armature lever and magnet, which is of the clapper type. When the current is turned on, the magnet is energized and the armature lever overcomes the pressure of compression springs through a toggle and releases the brake shoe grip upon the wheel.

Grinding Machine for Valves and Re-seating Tools: Carrier-Koeth Mfg. Co., Coudersport, Pa. A machine adapted for truing the poppet valves of gasoline engines or for grinding the cutters used for truing the valve seats. The grinding wheel is dressed to the proper angle by a special fixture, and the axis of the valve or re-seating tool is parallel with the wheel-spindle while being ground. The work- and wheel-spindles are connected by gearing having a ratio of 14 to 1. The feed is controlled by a micrometer screw.

Electrically Driven Drill and Grinder: Gilfillan Bros. Smelting & Refining Co., Los Angeles, Cal. Portable electrically driven drill provided with ball bearings throughout. It is equipped with gears and has two speeds ranging from 400 revolutions per minute on low speed to 700 revolutions per minute on high speed. This concern also manufactures a tool-post type of grinder adapted for use on lathes. It is provided with a 6- by $\frac{3}{8}$ -inch wheel and an extension mandrel for internal grinding fitted with a $1\frac{1}{2}$ - by $\frac{3}{8}$ -inch wheel.

Storage Battery Truck and Tractor: Elwell-Parker Electric Co., Cleveland, Ohio. The truck is equipped with a revolving jib crane having a capacity of 1000 pounds and a maximum reach of 48 inches. The truck can also be used as a tractor. A tractor is also built by this company intended for medium surfaces and having a single front wheel. The tractor has a normal draw-bar pull of 300 pounds and a maximum pull of 850 pounds. The speed without load is 625 feet per minute. Both the truck and tractor have a single reduction worm drive.

Cylinder Re-boring Tool: Universal Tool Co., Detroit, Mich. This tool may be hand-operated or used in conjunction with a drilling machine and it is made in several sizes, suitable for re-boring cylinders of automobile engines, etc. Each tool may be adjusted for different diameters, the No. 2 size having a range of expansion from $2\frac{1}{2}$ to $3\frac{1}{4}$ inches, and the No. 5 size from $2\frac{1}{2}$ to $5\frac{1}{16}$ inches. The cutter-head is equipped with six cutters, which may readily be adjusted in unison. The feed mechanism is so arranged that the feeding movement may be varied from 6 to 30 turns to the inch.

Electric Spout Welding Machine: Thomson Electric Welding Co., Lynn, Mass. This machine is arranged especially for welding spouts that are stamped in halves. These halves are held together in a special form of copper die and the projecting edges of the spout are brought into contact with a revolving vertical die extending through the top of the machine table, which is made of copper. The current passes through this plate and then through the copper die and projecting edges of the spout and the revolving vertical die. In this way, the spout edges are rapidly heated, and a slight pressure serves to force them down practically flush as they are welded.

Electric Seam-welding Machine: Thomson Electric Welding Co., Lynn, Mass. Line of machines for welding seams in sheet iron and steel. There are two distinct types, one being driven through a motor, toothed clutch and worm, while the other is supplied with a speed reducer and crank mechanism. Both types have traveling upper dies, while practically any form of lower die or jig suitable for cylindrical or cone-shaped work can be applied. One machine is intended primarily for welding longitudinal seams on cans, flat pieces, rectangular shapes such as metal boxes, etc., and the other is used for welding cans, stove burners, match boxes, revolver magazines, and similar parts.

Universal Turret Lathe: Acme Machine Tool Co., Cincinnati, Ohio. This machine has a capacity for round bar stock up to $3\frac{1}{2}$ inches in diameter and for chuck work up to 17 inches in diameter. A carriage between the turret slide and headstock may be used to advantage on either chuck or bar work. The machine has centralized control, all operating levers being conveniently located. The geared head is arranged to give nine speed changes, varying from 14 to 280 revolutions per minute. These changes may be made without stopping the spindle and are controlled by two levers. The turret is the flat type and has a cross-slide. Both the side carriage and turret have power feed for the cross and longitudinal movements. The simplex roller feed for bar stock is operated by the same lever that controls the chuck. A chasing attachment is furnished with the machine and a taper attachment may be applied.

HELPING UNCLE SAM

The Ordnance Department, Motor Equipment Section, Procurement Division, 6th and B Sts., N.W., Washington, D. C., has announced that catalogues from all automobile manufacturers, as well as from automobile accessory manufacturers, are required by the section. Manufacturers, therefore, can render a service to the Government by sending such catalogues directly to the department.

The Bureau of Ordnance, Navy Department, is in need of draftsmen who have had a number of years of drafting-room experience and who are competent designers of heavy machinery, engines, or shop tools. The pay ranges from \$4 to \$6.88 per day, depending upon the qualifications of the draftsman. Additional information may be had by addressing the Commandant and Superintendent, Navy Gun Factory, Navy Yard, Washington, D. C. The Federal Civil Service Commission, Washington, D. C., also requires mechanical and structural steel draftsmen for the government service as ship draftsmen. There is a great scarcity of ship draftsmen to carry out the government ship building program.

The United States Employment Service of the Department of Labor, Washington, D. C., is calling for 250,000 men suitable for work in shipbuilding yards. It is desired to bring men from parts of the country and from industries where employment is scarce to the seaboard where employment is plentiful, so as to prevent one shipyard taking men from another. Men who wish to enroll as shipyard workers should notify the Public Service Reserve, Department of Labor, Washington, D. C., to that effect. The classes of men that are wanted in the mechanical fields are oxy-acetylene and electrical welders, blacksmiths, drop-forge men, flange turners, furnace men, boiler makers, chippers and calkers, electric crane operators, foundry workers, templet makers, machinists, machine hands and helpers, sheet metal workers, structural iron workers, and laborers of all kinds.

Several thousand men are also required for what is to be known as the Motor Mechanics Regiment, in which are to be enlisted automobile and gas engine men who understand manufacturing and repair work on high-class gasoline engines. This regiment will include not only gas engine mechanics but also blacksmiths, oxy-acetylene welders, wheelwrights, and skilled machinists of all classes. Men who would like to enlist in this force should apply to the nearest Army recruiting station. More than 50 per cent of the men so enlisted will rank as non-commissioned officers with rates of pay ranging up to \$100 a month for those especially qualified, plus a family allowance for dependents ranging from \$5 to \$50 a month. The work will consist mainly in repairing airplane engines. Such men are scarce, and it is expected that most of the men who enlist will be from eighteen to twenty years of age. Men of draft age cannot enlist.

* * *

FEBRUARY MEETING OF A. S. M. E.

At the February meeting of the New York section of the American Society of Mechanical Engineers, held at the Engineering Societies Bldg., 29 W. 39th St., New York City, February 21, the subject of non-essential industries was discussed. A number of speakers representing various industries that are generally considered non-essential had been invited to present the case of their particular line of endeavor and to show how their industries might be diverted during the period of the war to the manufacture of articles that are required in the prosecution of the war. The meeting passed a resolution to request the council of the society to appoint a committee to aid manufacturers in gradually converting plants manufacturing non-essentials into plants manufacturing something absolutely necessary for the nation in war time. The difficulties of the small manufacturer in obtaining contracts for war work were pointed out, the Government preferring to give out contracts to large firms only. This keeps idle a great number of small plants that could do very useful work.

SAFEGUARDING WAR INDUSTRIES FROM ENEMIES WITHIN SUNDERLAND SPUR AND SPIRAL GEAR PLANERS

The National Americanization Committee, 29 W. 39th St., New York City, has issued a number of rules which should be observed by American industries, particularly those making munitions or which are vital to the conduct of the war. The observation of these rules (given below) would be, no doubt, of value in safeguarding against the efforts of our enemies.

Take a census of the personnel and keep thereafter a current registration, dividing all workers into six groups: Native-born, naturalized, first papers, second papers, alien enemies, all others. All subjects of the Central Powers as well as all other aliens without first or second papers, including both men and women, should be classified as of "doubtful loyalty" from a safety viewpoint.

Make an analysis of the physical conditions of the plant, then chart or map the location of the vulnerable points, noting particularly places where fire and explosions will do the most damage, where lights are important, where switchboards are placed, and where water supply hydrants are located. The location of indispensable and delicate machinery which can be easily injured and which is difficult to replace should also be noted. Include in this analysis the routing of products to local shipping points, to ascertain where they can be most easily tampered with.

Ascertain how each vulnerable spot is protected and how it is manned, and then gradually shift into these places only native-born men and women, who are in sympathy with present war policies, at the best possible rate of pay.

Provide only those of native birth to act as guards and sentinels, and place them in accordance with the results of this analysis, both as to the plant conditions and the distribution of employees.

Secure only those of native birth to act as watchmen, pay them the best possible wage rates, and constantly remove all causes for dissatisfaction.

Do not issue a general tag or number to foreign-born workmen which entitles them to visit at will different departments of the plant. The man who can do little damage when carefully placed, may be a good risk, but may prove dangerous if allowed to roam about the plant. Place restrictions on bringing packages into the plant and locate lunchrooms away from danger zones or vulnerable spots.

Require credentials and verify them, and see that visitors are permitted to go only to the places intended. Escort them in, stay with them, and see them out.

Decrease the labor turnover in every possible way so as to keep down the number of new men and women taken into the plant. Find out as much as possible about all new employees and keep the information up to date.

Appoint some employee as an Americanization captain who understands the alien. Give him a committee of leaders of the foreign-born if he wants one. It will be his duty to get in touch with the foreign-born employees, take some interest

The Sunderland generating type of spur-gear planer which was described in *MACHINERY*, February, 1910, has been re-designed, and (according to a recent description in *Engineering*) is now constructed for cutting either spur or spiral gears. The spiral gear planer operates on the same general principle as the one used for spur gears, but the cutter-slide is mounted on a swiveling base so that it may be set to conform with the helix angle of the gear. A general view of the spiral gear planer is shown in Fig. 1. The gear teeth are generated by a rack type of cutter having five or six teeth ordinarily.

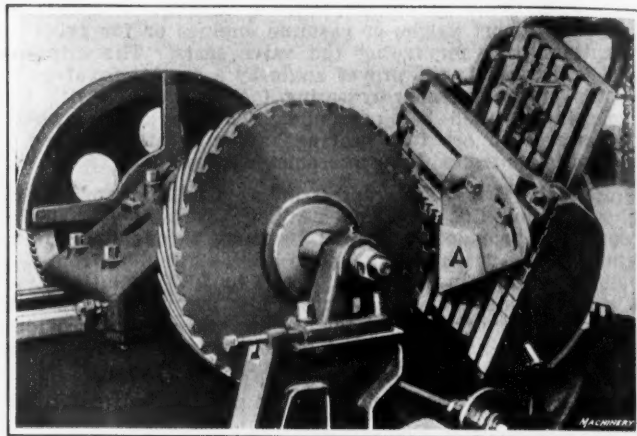


Fig. 2. Detail View of Planer cutting a Helical Gear

When the machine designed especially for spur gears is in operation, the cutter is traversed parallel with the axis of the gear blank and tangentially to the periphery of the blank by a feeding movement occurring each time a cutting stroke has been made. The blank is also given a rotary feeding movement, so that the rack-shaped cutters will generate the required gear tooth form. The movements of the cutter and gear blank are synchronized to correspond to those of a rack and gear in mesh. After a distance equal to one pitch has been cut, the movement of the cutter is arrested and the rack is indexed backward an amount equal to one pitch, after which the cutter is again moved tangentially, and so on until the gear is finished. The main shaft of the machine is driven from a pulley running at constant speed, and it makes four revolutions forward to impart the feed to the cutter tangent to the periphery of the blank and then four revolutions backward for returning the cutter to the starting position.

Helical gear teeth are generated by movements similar to those required for spur gears, except that the cutter is traversed at an angle with the axis as indicated by the detailed view, Fig. 2. The cutters used for spur gears may also be used for the spiral or helical type, provided the normal pitches of the spiral gears are the same as those of standard spur gears. When cutting large helical gears having teeth that incline considerably, or those of steep angles, cutters of greater length than the standard will be required in order to include more teeth. The detailed view, Fig. 2, shows the rim stay A moved back in order to expose the cutter. When setting up the machine, it is merely necessary to consider the pitch and the angle of inclination of the teeth. The

total lead of the helix does not need to be considered as in milling machine practice. The change-gears for pitch are selected for the real circular pitch and the cutter is chosen with reference to the normal pitch. A longer stroke of the cutter is required when planing helical gears than is necessary for spur gears of equal width in order that the cutter may clear the blank at each end of the stroke. The machines arranged

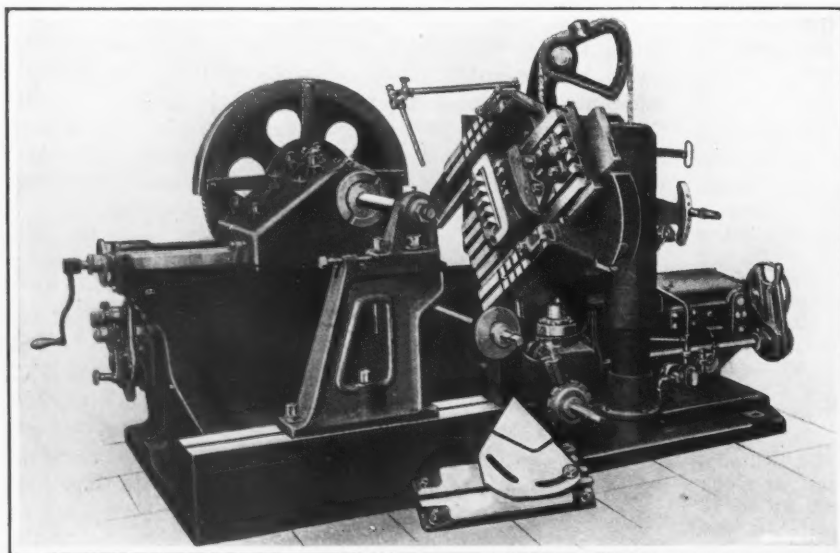


Fig. 1. Generating Planer for cutting Helical or Spur Gears

in them, see that they get the information they seek on registration, the draft, the interpretation of government orders, and other special questions that come up. It will pay to keep close to the foreign-born employees and help them get the right information.

Remove as promptly as possible every possible medium of unrest that enemies can work through—such as difficulties regarding hours, wages, housing, methods of employment, minor grievances, etc.

for helical gears may, of course, be applied to spur gears. The largest machine of this design has a capacity for gears varying from 4 inches to 4 feet in diameter with a maximum face width of 9 inches. This machine will cut gears having a maximum circular pitch of 2 inches or $1\frac{1}{2}$ diametral pitch. These gear planers are manufactured by J. Parkinson & Son, Shipley, Yorkshire, England.

A TRAVELING ANTI-WASTE EXHIBIT

In a large manufacturing plant where thousands of men and women are employed, large quantities of food products and manufacturing material are wasted daily. To give the employees of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., some idea of the waste, the management devised the novel scheme of fitting up a storage battery truck as a traveling exhibit, upon which was shown a collection of wasted food, as well as a quantity of discarded manufacturing materials such as copper, zinc, lead, mica, etc., much of which could be used to advantage. It is estimated that the food stuff wasted per day amounts to between \$35 and \$50, the cost of which, of course, comes out of the employees' pockets; the waste of material amounting to hundreds of dollars per day, which



An Exhibit of Food and Material wasted in a Large Manufacturing Plant

is a loss to the company, is due largely to the thoughtlessness and carelessness of the employees.

Above the material on the exhibition truck is a sign on which appears in large letters the word "Wasted"; over the food are the words, "Food Brought from Your Homes", and over the wasted material, "Material Belonging to the Company." This truck is driven up and down the shop aisles so that the employees can look at it and obtain some idea of the waste. Such an object lesson is valuable at this time when everyone should take all the precautions necessary to effect as little waste as possible.

ESTABLISHMENT OF INTERNATIONAL TRADEMARK BUREAU IN HAVANA

Dr. Mario Diaz Yrizar, an attorney of Havana, has been appointed director of the international bureau for the registration of trademarks to be established at Havana, Cuba. It is to be expected, therefore, that the bureau will shortly be prepared to assume the functions conferred by the convention regarding trademarks adopted at the Fourth Pan-American Conference in Buenos Aires in 1910. This convention agreed that any mark duly registered in one of the signatory states shall be considered as registered also in the other states of the union, without prejudice to the rights of third persons and to the provisions of the laws of each state governing the same. The twenty-one republics forming the Pan-American union are divided into two groups, with Havana as the center for the countries of North and Central America and the West Indies and Rio de Janeiro as the center for the South American countries. For the administration of this provision, two bureaus for the registration of trademarks are to be estab-

lished. Either bureau may be established upon the ratification of this agreement by two-thirds of the countries of the respective groups. At present Mexico, Salvador, and Hayti are the only countries of the northern group that have failed to ratify it.

In order to enjoy the benefit of the foregoing, the manufacturer or merchant interested in the registry of the mark must pay, in addition to the fees or charges fixed by the laws of the state in which application for registration is first made, the sum of \$50 in gold, which sum shall cover all the expenses of both bureaus for the international registration in all the signatory states.

The bureau at Havana will be supported on a pro-rata basis by all the American republics of the northern group that have ratified the agreement. Its operation will be under the direction of the Cuban government, with the consultation of the United States commissioner of patents and the new director of the international bureau, as well as with analogous officials in the other countries of the union. Until the second bureau is established at Rio de Janeiro, registration at Havana will presumably apply only to the countries of the northern group. Upon the establishment of both bureaus, however, registration in either will give full protection in all countries that have ratified the agreement.

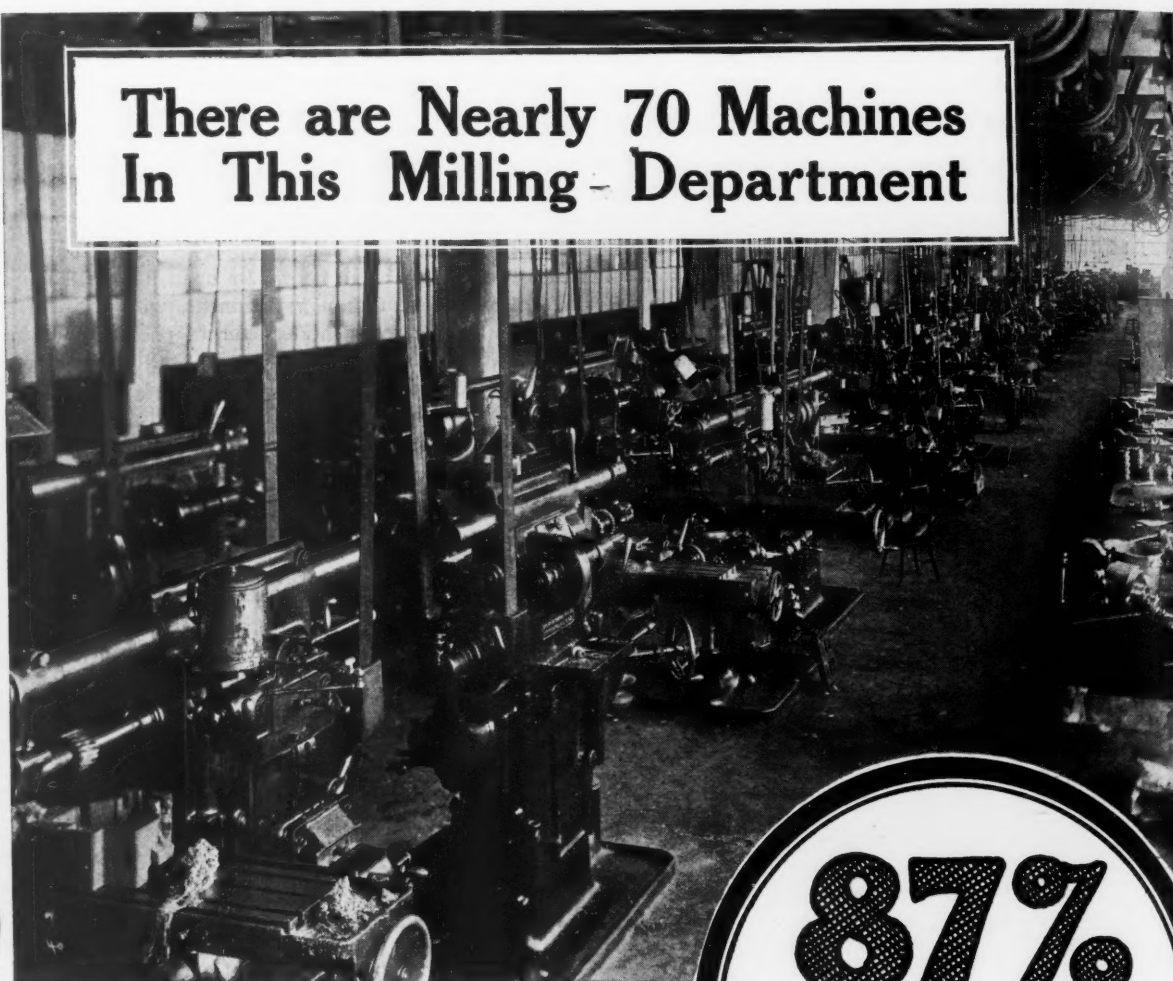
RULES GOVERNING INDUSTRIAL PRIORITIES

Circular No. 3 of the War Industries Board states that during the present war all orders and work done by individuals, firms, associations, and corporations engaged in the production of copper, iron, and steel, and in the manufacture of products thereof, are divided into classes AA, A, B, and C. For convenience, these are also subdivided into AA-1, AA-2, etc. Class AA comprises only emergency war work of an exceptional and urgent nature and takes precedence over all others. Class A comprises all other war work and takes precedence over all others except class AA. Class B comprises orders and work which, while not designed for the prosecution of the war, are essential to the national welfare, or otherwise of exceptional importance; it takes precedence over class C, in which all other orders and work are placed. This classification, however, does not affect the standing of priority certificates already issued.

The classification of an order simply means that it shall be given only such precedence over orders of a lower classification as may be necessary to insure delivery on the date specified in the order. It does not mean that work should cease on orders of a lower classification, or that the order should be completed and delivery made in advance of orders taking a lower classification if this is not necessary to effect delivery within the time specified. The one to whom a priority certificate is directed should make his own production plans, so as to get the maximum efficiency out of his operations, making all deliveries at the times contracted for, if possible, and where this is not possible, giving precedence to the orders taking the highest classification. In case of doubt, questions as to priority should be laid before the Priorities Committee, War Industries Board, Council of National Defence, Washington, D. C. The Priorities Committee does not issue priority orders for fuel, food, transportation, export or import, nor will it grant blanket certificates for an industry, plant, material, or commodity.

Before the war practically all the magnesium used in the United States was imported from Germany. Hence, there has recently been a great scarcity of this metal. A few months ago, however, a corporation was organized at Niagara Falls for the production of magnesium and magnesium alloys. A plant has been built which is now in operation, and sufficient quantities have already been placed on the market to reduce the price. Magnesium is used mainly in an alloy of magnesium and aluminum for airplane parts. An alloy can be produced from these metals, containing other metals in small quantities, which has a specific gravity much less than that of aluminum.

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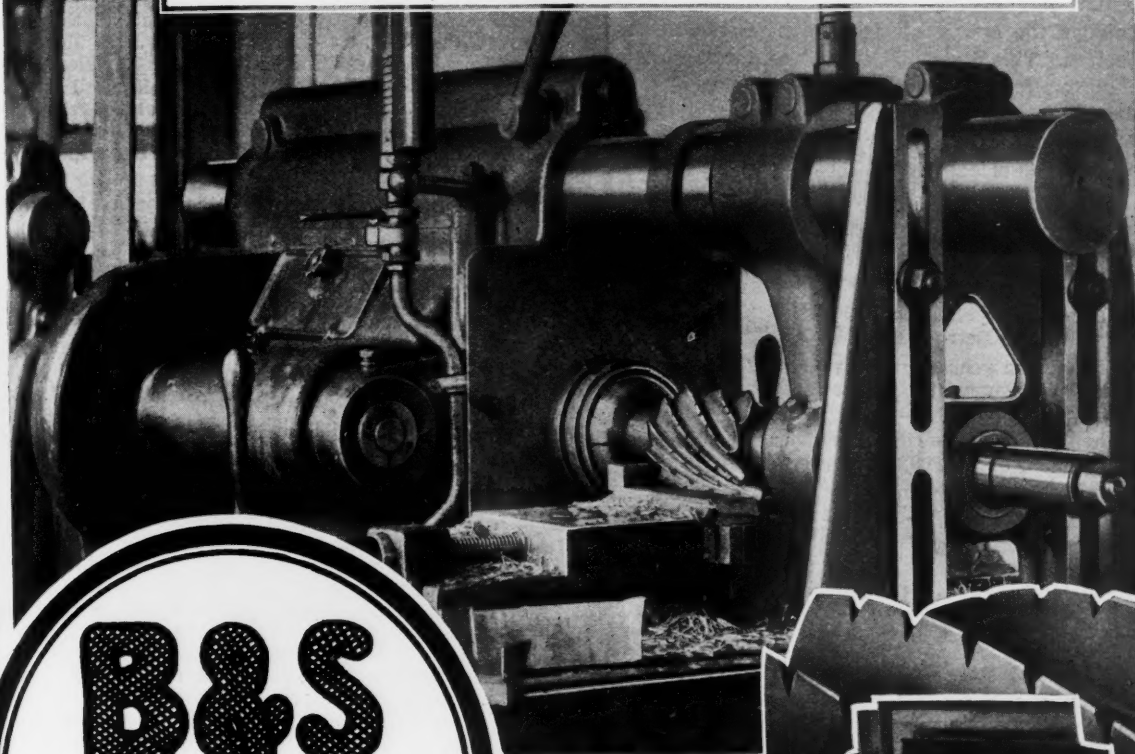
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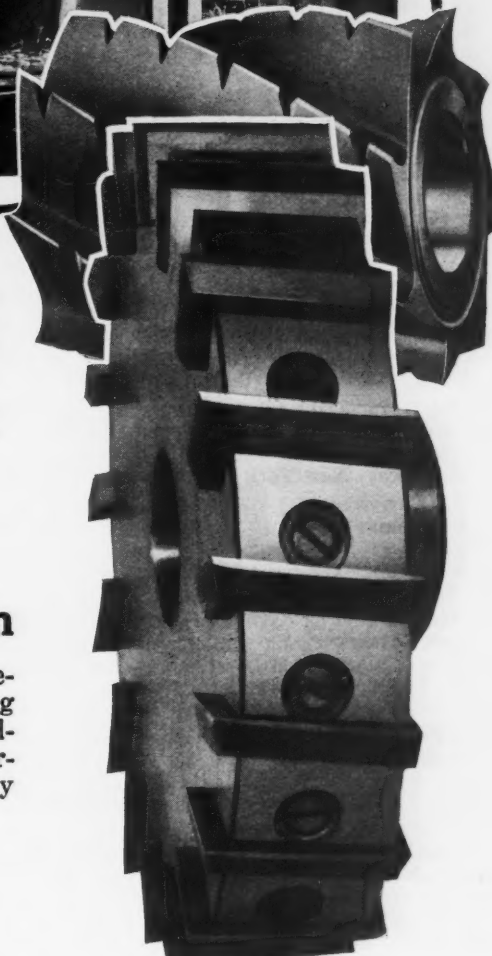
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REMOVAL OF HEADQUARTERS OF WAR DEPARTMENT AIRPLANE PRODUCTION SECTION

It has been announced by the Office of the Chief Signal Officer of the Airplane Production Section of the War Department that the headquarters of the section have been removed to Union Block, 1836 Euclid Ave., Cleveland, Ohio, and that all correspondence relative to airplanes, engines, and spare parts of airplanes should be sent to this address.

* * *

Women supervisors will be stationed by the Ordnance Department of the Army in every district where women are employed in munition plants. They will be appointed by Mary Van Kleeck, chief of the new women's division of the Industrial Service Section. This division, besides maintaining proper working conditions for the women in the munition plants, will concern itself with the housing of the women workers and the establishment of canteens where they may obtain wholesome food at cheap prices.

PERSONALS

Donald A. Baker is now chief engineer for the Anderson Drop Forge & Machine Co., Detroit, Mich.

J. B. Phillips, for eleven years superintendent of the Borden Co., Warren, Ohio, has resigned to become factory manager of the Nye Mfg. & Tool Co., Chicago, Ill.

H. D. Gates has returned to the Pangborn Corporation, Hagerstown, Md., as sales manager, which position he resigned about four years ago to take charge of the Mott Sand-Blast Co.

H. F. Finney, who covered the Chicago and St. Louis territories for the Independent Pneumatic Tool Co., Chicago, Ill., has been placed in charge of the company's branch offices at Pittsburg, Pa.

C. H. Davies has been made publicity manager for S. F. Bowser & Co., Fort Wayne, Ind. Mr. Davies has been in the employ of the company for several years and was recently manager of the New York store.

Leslie A. Holman, superintendent of the American Watch Tool Co., Waltham, Mass., is now in Montreal, Canada, designing special machinery. The plant of the American Watch Tool Co. was recently sold at auction.

George L. Hedges has resigned his position with the Kelman Electric & Mfg. Co., Los Angeles, Cal., to report at Washington, D. C., for active duty as First Lieutenant in the Officers' Reserve Corps, Ordnance Department.

Charles O. Watson, formerly of the Niles-Bement-Pond Co., has become associated with Young, Corley & Dolan, Inc., 115 Broadway, New York City, in the capacity of assistant manager of the Machine Tool Department.

R. T. Scott, formerly office manager of the Pittsburg branch of the Independent Pneumatic Tool Co., Chicago, Ill., has been made eastern manager of the company with headquarters at 170 Broadway, New York City.

Earl E. Eby, who was manager of the Pittsburg office (Industrial Bearings Division) of the Hyatt Roller Bearing Co., Newark, N. J., for the past two years, has been appointed assistant sales manager, with headquarters in the Metropolitan Tower, New York City.

F. J. Hull, who was connected with the Pangborn Corporation, Hagerstown, Md., as engineer about five years ago, and who has been more recently in the employ of the Mott Sand-Blast Co., has returned to the Pangborn Corporation in the capacity of assistant engineer.

S. W. Brainard, formerly mechanical engineer for the Cleveland Pneumatic Tool Co., superintendent of the Niagara Fire Extinguisher Co., and general superintendent of the Automatic Sprinkler Co. of America, has been appointed factory manager of the Borden Co., Warren, Ohio.

H. B. Hammond, formerly of the Industrial Department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has now become associated with the firm of Young, Corley & Dolan, Inc., 115 Broadway, New York City, as manager of the Electric and Railway Department of Sales.

F. C. Hossie has purchased all J. R. Stone's holdings in the General Mfg. Co., Detroit, Mich., and sold all of his holdings in the J. R. Stone Tool & Supply Co., with which he has been identified for a number of years. Mr. Hossie will devote his whole time to the interests of the General Mfg. Co.

R. S. Cooper, vice-president of the Independent Pneumatic Tool Co., Chicago, Ill., who was for many years manager of the eastern branch of the company in New York City, has assumed the duties of general sales manager, as well as those

of vice-president, and will maintain his headquarters at the general offices of the company, Thor Bldg., Chicago, Ill.

Charles T. Bird, who has been identified with the Production and Engineering Departments of the Pangborn Corporation, Hagerstown, Md., has been transferred to the Sales Department with headquarters at Hagerstown. His territory will include eastern Pennsylvania, southern New York, New Jersey, Delaware, Maryland, District of Columbia, and Virginia.

G. F. Evans, formerly with the W. C. Moore Co., Columbus, Ohio, has been appointed supervising engineer by the National X-Ray Reflector Co., Chicago, Ill. Mr. Evans' territory will comprise the state of Ohio (with the exception of Toledo and Cincinnati), West Virginia, and western Pennsylvania, and his headquarters will be at 825-826 Columbus Savings & Trust Bldg., Columbus, Ohio.

Waldo H. Marshall, formerly president of the American Locomotive Co. and now associated with J. P. Morgan & Co., has been appointed assistant chief of the Division of Production of the Ordnance Department. Mr. Marshall is first vice-president of the Merchants' Association and was on the staff of Edward R. Stettinius (now surveyor general of supplies in the War Department) in the Munitions Department of J. P. Morgan & Co.

Sir Harry Smith, chairman of the board of management of the Keighley National Shell Factories, has received an appointment of knighthood in the British Empire Order, as a fitting recognition of the valuable work that he has done in the efficient organization and conduct of the Keighley shell factories. Sir Harry has been president of the Keighley Chamber of Commerce and is a representative of the Ministry of Munitions. He is also one of the owners of the firm Dean, Smith & Grace, Ltd., which, since the outbreak of the war, has been engaged night and day in the manufacture of lathes for all kinds of munitions. There has been a general expression of satisfaction throughout the British machine tool trade in consequence of the recognition that has been given to Sir Harry.

Elliot A. Kebler has become president of the Fawcus Machine Co., Pittsburg, Pa., succeeding the late Thomas Fawcus. Mr. Kebler was, for many years, with the Cincinnati Pipe Co. and their successors, the Addyston Pipe & Steel Co., starting in first as a chemist and later as secretary of the company, during which time he had charge of the building of the new plant. When this company was merged with the U. S. Cast Iron Pipe & Foundry Co., he remained with the Matthew Addy Co., of Cincinnati, Ohio, devoting his time principally to the sale of pig iron. He was one of the incorporators of the Fawcus Machine Co. and has been secretary and treasurer of that company from its incorporation. As president of this company, he will still remain special representative of the Matthew Addy Co.

OBITUARIES

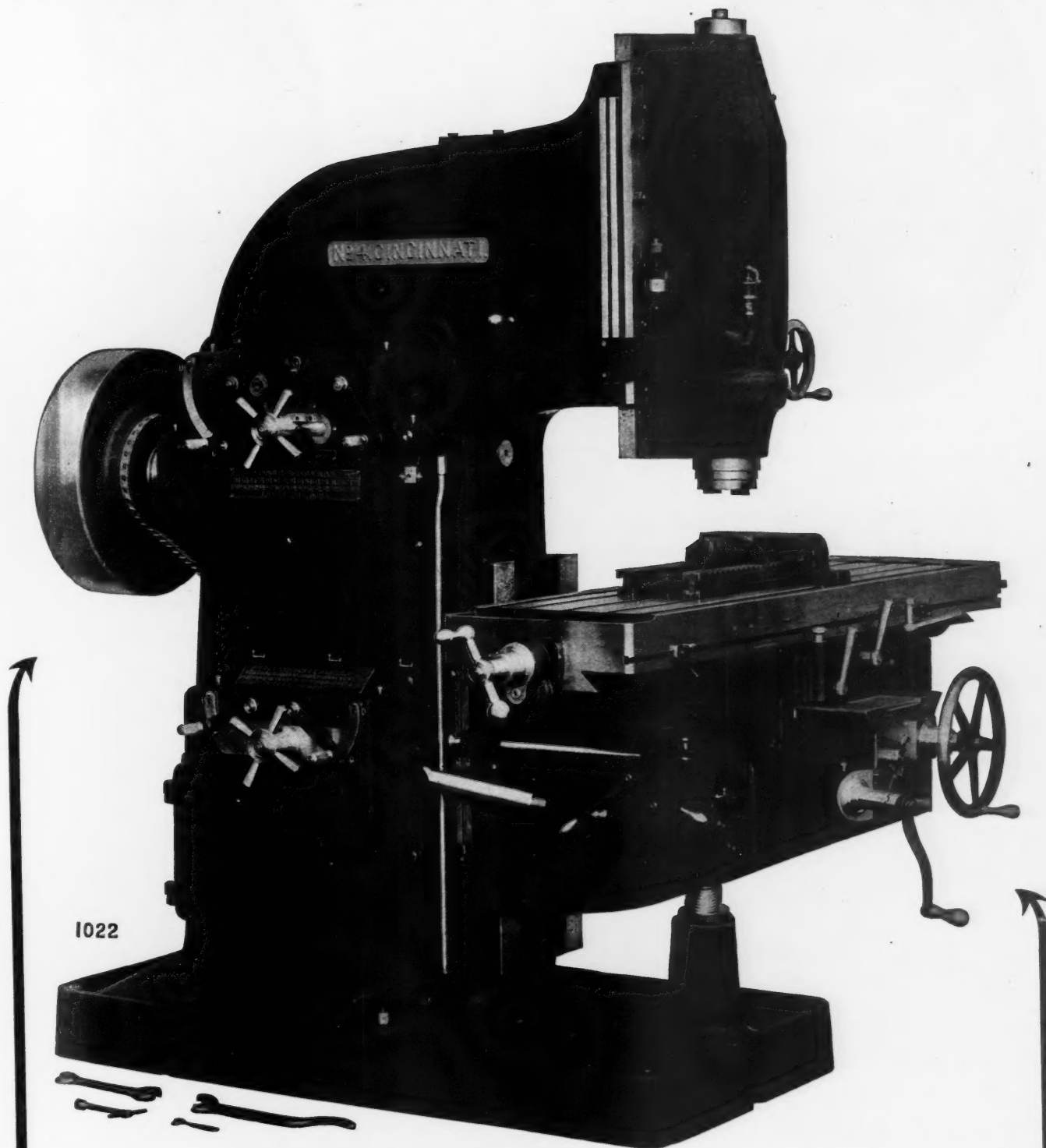
George J. Althen, treasurer of the Driver-Harris Co., Harrison, N. J., died February 15. Mr. Althen was born in Newark, N. J., in 1857, and for the past four years has been connected with the Driver-Harris Co. He was well known on account of his affiliation with the National Credit Men's Association, and was a member of the executive committee, representing New Jersey.

Thomas Fawcus, president of the Fawcus Machine Co., Pittsburg, Pa., died January 22, aged fifty-two years. He organized the Fawcus Machine Co. in 1900, and, due to his executive and inventive ability, the growth of the business was rapid. In 1912 he started to design and develop the Fawcus herringbone gear-cutting machine, which is covered with patents in the United States and foreign countries.

ARTHUR IRVING JACOBS

Arthur Irving Jacobs, president of the Jacobs Mfg. Co. and the Rhodes Mfg. Co., Hartford, Conn., died February 16, at St. Francis Hospital, in Hartford, after a brief illness. Mr. Jacobs was born in Hebron, Conn., in 1858. His educational advantages were meagre during his boyhood, and after his ninth year his schooling was limited to a short period in the winter; but he was early trained in habits of industry, working with his father, Zalmon Luman Jacobs, in mechanical work until he attained his majority, when he secured employment in the Knowles Loom Works at Worcester, Mass. There his mechanical bent soon became manifest and in a short time he made such improvements in manufacturing methods on a contract for the making of harness chains for looms that he was able to earn a good profit where others had previously failed. Mr. Jacobs remained at the Knowles Loom Works until 1887, during which period he invented and built a book-sewing machine of which several were purchased by Boston book binders. The Smyth Mfg. Co., of Hartford, Conn., which also manufactured such machines, became interested in his invention, purchased his patents, and engaged Mr. Jacobs to come to Hartford. He

Cincinnati Verticals



**Unusual Spindle Power.
Heat Treated Alloy Steel Hardened Gearing.
Massive Spindle Head Construction.
Handy—Can mill around a rectangle without
stopping feed or speed.**

These are some reasons why you should use Cincinnati Verticals

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.



Arthur Irving Jacobs

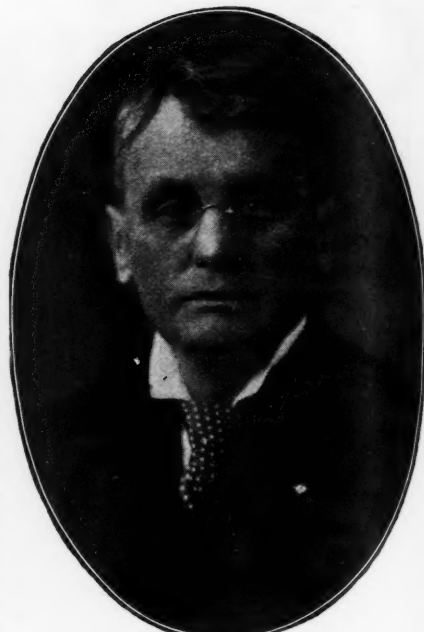
now occupying a large modern factory on Park St., built to suit the company's needs. Mr. Jacobs married in 1880, Lucy Ann Backus, of Hebron, Conn., who died in 1908. He later married Marguerite Serrell, of Park Ridge, N. J., who survives him. Mr. Jacobs is also survived by three children in his first marriage; one son, Raymond Backus Jacobs, secretary of the Jacobs Mfg. Co. and the Rhodes Mfg. Co., and two daughters, May Louise and Clara Bell, the latter the wife of Louis E. Stoner, treasurer of the Jacobs Mfg. Co.

remained with the Smyth Mfg. Co. until 1901, during which period he invented and developed several machines for book-binding; among these were two machines for making book covers and for cutting cloth for book covers, which marked a great advance over methods that had formerly been employed.

In 1902, he invented the drill chuck that is known as the "Jacobs improved drill chuck," patent on which was allowed September 16, 1902. The Jacobs Mfg. Co. was incorporated in 1903; manufacturing was started in rented quarters, but the business

H. H. HODELL

Henry H. Hodell, president of the Van Dorn & Dutton Co., Cleveland, Ohio, gear specialist, and of the Cleveland Galvanizing Works Co., manufacturer of weldless wire chain, and a director of the Van Dorn Electric Tool Co., died February 10, aged sixty-eight years. Mr. Hodell was born in Alsace-Lorraine and came to America with his parents as a small boy. After having finished his early education, he learned the pattern-maker's trade, but it was not long before his business ability was recognized by those with whom he came in contact. As a result, in the early eighties he entered the galvanizing business, and from a very modest beginning, he soon built up one of the largest custom galvanizing businesses in the country. He was also a pioneer in the weldless wire chain business, one of the best known link-chains bearing his name. Later he became one of the founders of the Van Dorn & Dutton Co. and of the Van Dorn Electric Tool Co., both of Cleveland, Ohio. He leaves a widow and two sons, F. G. Hodell, and H. H. Hodell, who were associated with him in his many enterprises.



Henry H. Hodell

COMING EVENTS

March 20-22—Annual meeting of the American Railway Engineering Association, 910 Michigan Ave., Chicago, Ill.

March 28—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

April 10-12—Sixth annual meeting of the Chamber of Commerce of the United States of America, at the Congress Hotel, Chicago, Ill.

April 18-20—National Foreign Trade Council conference in Cincinnati, Ohio; Gibson Hotel, headquarters. Secretary, O. K. Davis, 1 Hanover Square, New York City.

April 24-25—Annual convention of the National Metal Trades Association at the Hotel Astor, New York City. Homer D. Sayre, secretary, 1021 Peoples Gas Bldg., Chicago, Ill.

May 15-17—Joint convention of the National Supply and Machinery Dealers' Association, Southern Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association in Cleveland, Ohio. Secretary of the American Supply and Machinery Manufacturers' Association, F. D. Mitchell, Woolworth Bldg., New York City.

June 20-22—Fifth annual convention of the American Drop Forge Association held at the Iroquois Hotel, Buffalo, N. Y. E. B. Horne, "The American Drop Forger," 108 Smithfield St., Pittsburgh, Pa., secretary.

NEW BOOKS AND PAMPHLETS

The Collapse of Short Thin Tubes. By A. P. Carman. 36 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the University of Illinois, Urbana, Ill., as Bulletin No. 99.

The Hydrometallurgy and the Electrolytic Precipitation of Zinc. 28 pages, 6 by 9 inches. Published by the School of Mines and Metallurgy, University of Missouri, Rolla, Mo., as Bulletin No. 1 of the Technical Series, Volume IV.

Specific Heat of Liquid Ammonia. By Nathan S. Osborne and Milton S. Van Dusen. 35 pages, 7 by 10 inches. Published by the Government Printing Office, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 313. Price, 5 cents.

Latent Heat of Vaporization of Ammonia. By Nathan S. Osborne and Milton S. Van Dusen. 32 pages, 7 by 10 inches. Published by the Government Printing Office, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 315. Price, 10 cents.

Engine Guarding and Engine Stops. Published by the National Safety Council, Continental and Commercial Bank Bldg., Chicago, Ill., as Safe Practices Bulletin No. 9. Price, 10 cents.

This bulletin describes safety devices and methods of guarding engines and engine stops; it contains information on safe speeds for flywheels, various materials for flywheel rims, causes of flywheel accidents, care of safety stops, piston clearances, engine piping and drains, lubrication of air compressor cylinders, etc.

Shafting, Couplings, Pulleys, Gearing. Published by the National Safety Council, Continental and Commercial Bank Bldg., Chicago, Ill., as Safe Practices Bulletin No. 8. Price, 10 cents.

This is one of a series of pamphlets that will be sent to the 3470 industrial, railroad, and other members of the National Safety Council, and that will be accepted as standard safe practices to protect the lives and limbs of workmen. Bulletin No. 8 describes safety devices for shafting, couplings, pulleys, and gearing.

Combined Table of Sizes in the Principal Wire Gages. Published by the Bureau of Standards, Department of Commerce, Washington, D. C., as Circular No. 67.

This table combines in one series the sizes in the American (B. & S.), steel Birmingham (Stubs), British standard, and metric wire gages, arranged in order of diameters of wires. It gives the diameters of all the gage numbers in these five systems in mils, inches, and millimeters, as well as the cross-sections in square mils, circular mils, square inches, and square millimeters.

Industrial Arts Index. 558 pages, 7 by 9 inches. Published by H. W. Wilson Co., 958 University Ave., New York City.

This is the fifth annual cumulation, giving subject index to a list of engineering and trade periodicals for 1917. The work, which indexes articles that have appeared in practically all the leading trade journals, should be of considerable value to investigators of special industrial subjects, libraries, authors, and others who require a comprehensive index to all the information that has been published on any one subject during the past year.

Finding and Stopping Waste in Modern Boiler Rooms. 274 pages, 5 by 7 inches; numerous illustrations. Published by Harrison Safety Boiler Works, Philadelphia, Pa. Price, \$1.

This book may be considered as a reference manual to aid the owner, manager, and boiler-room operator in securing and maintaining plant economy. The subject matter was originally intended as an appendix to one of the catalogues of the Harrison Safety Boiler Works, but has grown into a separate volume with information of great value to those responsible for the operation of boiler plants. At the present time, when the saving of coal has become so important, anything relating to the economical operation of a boiler plant is of great value. The book contains five separate sections on fuels, combustion, heat absorption, boiler efficiency and testing, and boiler plant proportioning and management.

Location of Airplane Power Plant Troubles Made Easy. Chart arranged by Lieutenant Victor W.

Page. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 50 cents.

This is a large wall chart showing a typical airplane engine partially in section, with all the important components indicated. The chart can be conveniently folded up to be put into the pocket. It is printed on tough paper and will stand considerable handling. In addition to showing clearly the construction of an airplane engine, the chart outlines possible troubles likely to be met with in the operation of these engines, and deals with the cooling, lubrication, carburetion, and ignition, as well as with defects in the engine itself. The chart has been prepared by an expert on airplane engines, and is based on practical experience gained in the Government aviation service. It has been arranged with special reference to the needs of the student and the aviator who is not an expert in mechanics.

Machine Shop Practice. By William B. Hartman. 246 pages, 4 1/2 by 7 inches; 132 illustrations. Published by D. Appleton & Co., 35 W. 32nd St., New York City. Price, \$1.10.

This book may be termed a primer of machine shop practice, the object being to set forth the elementary principles only. The subject has been treated in a simple manner and arranged in logical order. Measuring tools are first illustrated, then hand and machine cutting tools are described, and finally machine tools are dealt with. The book is divided into twelve chapters dealing specifically with machine shop work, covering such subjects as measuring tools; chipping, filing, and scraping; drills and drilling machines; the lathe; straight turning; taper turning; thread cutting on the lathe; general lathe work; planer and shaper; boring mill; milling machine; and milling machine work. A special chapter on the automobile is included and also a number of useful tables.

Efficiency Methods. By M. McKillop and A. D. McKillop. 215 pages, 5 by 7 inches. Published by D. Van Nostrand Co., 25 Park Place, New York City. Price, \$1.50.

This book may be considered as an elementary text-book on scientific management. It contains a review of the subject of management and refers to many of the books and articles on the subject that have been published in the past. It deals specifically with the different departments organized under the scientific management system—the planning department, the cost department, the stores department, and the tool-room. Other chapters deal with the functions of foremen, time study and motion study, fatigue study, and task work. Methods of remuneration under scientific management and its relation to welfare work, trade unions, and education are also treated. On the whole, the book may well be recommended to anyone who wants to obtain a preliminary knowledge of the principles of scientific management.

Transmission Gears. By Edward Butler. 164 pages, 6 by 9 inches; 125 illustrations, including 9 folding plates. Published by J. B. Lippincott Co., Philadelphia, Pa.

The object of this treatise is to present in a concise form such information relating to mechanical, electric, and hydraulic transmission mechanisms as is especially useful to engineers, designers, and

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BORING, DRILLING AND

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others engaged in the application of internal combustion engines for automobile, marine, and other general purposes. The book deals specifically with friction clutches; speed change-gear mechanisms; transmissions between gear-box and road wheels; transmissions used in street railway cars, gasoline railway cars, and oil locomotives; marine reversing gears; reversible screw propellers; and electric, hydraulic, and compressed-air variable-speed transmissions. The relative adaptability of gradually variable transmissions—hydraulic and electric—have been explained in order to point out means for avoiding some of the inherent faults of step-by-step gears. The subject of friction clutches has been dealt with as exhaustively as possible, because of the importance of the subject and the difficulty of obtaining satisfactory designs. The book should be of value to those interested in the various types of transmission mechanisms that have been employed on automobile and marine internal combustion engines.

Aviation Engines. By Lieutenant Victor W. Page. 589 pages, 5½ by 8½ inches. 253 illustrations. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, \$3.

Considering the scarcity of good literature on airplane engines written from the practical point of view, this book should prove of considerable value to the great number of people who, at the present time, are engaged in air engine work. On account of the rapidly developing art, it is, of course, difficult to outline in a book all the latest forms or to describe current engineering practice, completely, but the book nevertheless appears to be accurate in its engineering information. Special attention has been paid to instructions on tool equipment, use of tools, and engine repairs. Theoretical considerations have been avoided, except when deemed absolutely necessary in order to secure a proper understanding of the action of the engine. The writer's efforts have been confined mainly to the preparation of a practical series of instructions that would be of particular value to those who must acquire quickly a diversified knowledge relating to internal combustion engine operation and repair. The writer's experience as assistant engineering officer in the Signal Corps Aviation School at Mineola, N. Y., has made it possible for him to determine quite accurately the kind of information relating to airplane engines that is most needed for instruction purposes, and the book is especially adapted for men in the aviation service of the Signal Corps, and for students who wish to become aviators or aviation mechanics.

Taylor System in Franklin Management. By Major George D. Babcock, in collaboration with Reginald Trauttschold. 245 pages, 5½ by 8½ inches. Published by the Engineering Magazine Co., 6 E. 39th St., New York City. Price, \$3.

The principal author of this book, who is production manager of the H. H. Franklin Mfg. Co., has in this work recorded the application of the Taylor system and the results obtained in the plant of this company. The work is one that those interested in the details of scientific management will study with interest. It is divided into ten chapters headed as follows: Factory Conditions in 1908; Investigation of the Taylor System; Classification and Standardization; Establishing Control; The Schedule; Control Boards, and Pneumatic Despatch Tubes; Employment and Rate Fixing; Organization Classification; Changes in Product and Method; Changes which have Affected the Men; The Results Graphically Depicted. Two appendices are also added, one giving wage rates in the Franklin shops, and one containing examples of the application of scientific management. Two features of the work might particularly be mentioned—the description of the control boards devised by Major Babcock, beginning on page 63, to which are largely due the remarkable increases in production which have been obtained, and the detailed description of the Franklin wage formula in the appendix, which has enabled the company to reduce its labor turnover to a most remarkable extent. The results obtained from the inauguration of the Taylor system are graphically described in the chapter beginning on page 147 and will be reviewed with interest by anyone confronted with management and production problems.

NEW CATALOGUES AND CIRCULARS

Baldwin Locomotive Works, Philadelphia, Pa. Record 88, descriptive of the Santa Fe type locomotives.

Baldwin Locomotive Works, Philadelphia, Pa. Record 89, treating of the development of the eight driving wheel locomotive.

Stevens Institute of Technology, Hoboken, N. J. Annual catalogue for 1918-19, containing calendar, courses of instruction, etc.

Cooper Flexible Transmission Co., Inc., Eighth Ave. and 18th St., Brooklyn, N. Y. Price list of Cooper patented machine universal joint.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue E, illustrating "Brownhoist" buckets and tubs in operation on various classes of work.

Nils E. Goodactive, Box 250, Chicago, Ill. Catalogue of the "Goodactive" belt shifter for cone belts, which is applicable to any machine with cone-belt drive.

Link-Belt Co., Chicago, Ill. Book 359, entitled "Chain-driven Motor Trucks and Tractors," illustrating installations of Link-Belt chain in trucks and tractors.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 31, treating of forging motor truck shafts on a National heavy-pattern forging machine.

Heinkel Machine Tool Co., Sandusky, Ohio. Circular descriptive of Heinkel silent multiple drilling heads designed for use in connection with single-spindle equipment.

Wright Roller Bearing Co., 1420 Chestnut St., Philadelphia, Pa. Catalogue of Wright taper roller bearings, describing and illustrating in detail the construction of this type of bearing.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Folder illustrating Shepard electric cranes and hoists and their installation in twenty-four plants for various classes of work.

Link-Belt Co., Chicago, Ill. Booklet 354, describing and illustrating the gravel washing and sand drying plant of the Absecon Sand Co., which was designed and equipped by the Link-Belt Co.

Newman Mfg. Co., 717-721 Sycamore St., Cincinnati, Ohio. Circular of "Spotlight" factory brackets, illustrating the different types and their application on various types of machines and giving price lists.

Charles F. Elmes Engineering Works, 222 N. Morgan St., Chicago, Ill. Classified collection of loose-leaf circulars, illustrating presses, oil machinery, accumulators, pumps, valves, fittings, gages, etc.

Gisholt Machine Co., 1200 E. Washington Ave., Madison, Wis. Pamphlet entitled "Increasing Production with Gisholt Machines," showing some interesting work that is being done on Gisholt turret lathes and tool grinders.

Fulfo Pump Co., Cincinnati, Ohio. Circular illustrating essentials in the construction of the Fulfo pump, which should be of interest to purchasers of coolant pumps. Letters of recommendation from a number of users are reproduced.

National Tube Co., Pittsburg, Pa. Circular showing a piece of 8-inch National line pipe, which resisted without fracture a twisting force of 713,000 inch-pounds. The circular also contains other illustrations showing the ductility of National tubing and pipe.

Cleveland Galvanizing Works Co., Cleveland, Ohio. Circular descriptive of a new swivel repair link, designed to facilitate the work of repairing chains. The "One-minute" swivel repair link is made in three sizes for use with different sizes of welded, weldless, or flat-link chain.

Cleveland Automatic Machine Co., Cleveland, Ohio. Pamphlet containing reprints of thirty-one articles by J. P. Brophy which have been published in various magazines. The articles deal with mechanical information, municipal problems, politics, human qualities, humor, war, and general business administration.

E. R. Senn & Co., 52 Vanderbilt Ave., New York City, has issued the first number of a house organ called "The Belt-ol Scrap Book" which will contain information on power efficiency and the use of Belt-ol for increasing the transmission efficiency of belts. The intention is to include each month items covering practical methods and experiences of prominent production and power plant managers.

Greenfield Tap & Die Corporation, Greenfield, Mass. Catalogue of the Wells self-opening die, treating of the advantage of self-opening dies and describing the construction of the Wells die. Dimensions of the pull trip, rim trip, and face and lever trip types are included. The book is illustrated with halftone and line engravings, making the construction clear to the non-technical man as well as to the engineer.

Walton Co., Hartford, Conn. Circular 70, describing the Walton tap extractor for removing broken pieces of taps. The device consists essentially of prongs or fingers suitably mounted, which are pushed into the flutes of the broken tap; the tap can then be easily screwed out. The prongs are made of a special crucible steel, having considerable strength, which is neither as hard nor as brittle as the tap.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Pamphlet A-2132, containing information on bakelite micarta-D gears. The distinctive features of this material for noiseless gears and pinions are listed, together with its physical properties. Methods of turning, drilling, and cutting gears in bakelite micarta-D are described and illustrated. The book also contains other information of value to those who are interested in the use of noiseless gears.

Fellows Gear Shaper Co., Springfield, Vt. Booklet entitled "The Stub-tooth Gear." This treatise explains in simple terms the advantages of the combination of a short gear tooth with an increased angle of obliquity. The treatment is very clear and complete, covering some fifty, 6- by 9-inch pages, and profusely illustrated with line engravings and halftones. The treatise is divided into five chapters: Development of Gear Teeth and Gear Tooth Proportions; Graphical Analysis of Gear Tooth Wear and Durability; Comparative Strength of 14½- and 20-degree Stub-gear Teeth; Advantages of the Stub-tooth Gear; and Graphical Method of "Generating" an Involute Gear Tooth. Treatises of this kind are a valuable addition to mechanical literature.

TRADE NOTES

Maxf Grinding Wheel Corporation, Chester, Mass., has opened an office at 15-17 S. Clinton St., Chicago, Ill., in charge of Hoffman & Meyer, where a large stock of grinding wheels will be carried on hand.

Special Tool Co., Whitman, Mass., has recently taken over all the assets, including machinery, stock, patents, good will, etc., and liabilities of the Worcester Flexible Tubing Co., Worcester, Mass.

Murray-Mylrea Machine Co., Antigo, Wis., has bought the disk grinder business conducted in the past by the Ransom Mfg. Co., Oshkosh, Wis. The

Murray-Mylrea Machine Co. will continue the manufacture of the disk grinders.

Crescent Tool Co., Jamestown, N. Y., is preparing plans for a power station and concrete coal storage bins and will shortly be in the market for a 1000-kilowatt steam turbine generator set and boilers, and a 1500-horsepower gas producer for supplying gas engines, forges, and furnaces.

High-Speed Tools Corporation, manufacturer of cast high-speed steel tools and alloyed steels, has removed its offices to 43 Exchange Place, New York City. The company is enlarging the capacity of its factory considerably, and expects to be able to assure its customers of the earliest possible delivery.

Hetherington-Jones Co., 523 W. Miami St., Piqua, Ohio, has been succeeded by the Hetherington Co., chartered under the laws of Ohio with a capitalization of \$25,000. The new company will continue the business of manufacturing emery wheel dressers and cutters, and other specialties in metal lines.

Trimont Mfg. Co., 55-71 Amory St., Boston, Mass., is constructing an addition to its plant. Part of the increased space will be given up to the office and the remainder will be used as an assembling room for the "Trimont" line of wrenches made by this company. The addition will be ready for occupancy in May.

General Mfg. Co., 93 Meldrum Ave., Detroit, Mich., manufacturer of tools, jigs, and fixtures, announces a change of officers due to a transfer of stock holdings. The new officers are F. C. Hossie, president; M. G. Hossie, vice-president; and H. Wild, secretary and treasurer. The business will be conducted along the same lines as heretofore.

Spartan Saw Works, 41 Taylor St., Springfield, Mass., manufacturers of hacksaw blades, have been formed by H. F. Strout and J. W. McQuillan, both of whom were formerly engaged with the Massachusetts Saw Works, the latter as general superintendent and president. Orders for hacksaws are now being received and a few orders have already been filled.

Ransom Mfg. Co., Oshkosh, Wis., manufacturer of grinding machinery, has sold its disk grinder business to the Murray-Mylrea Machine Co., Antigo, Wis., which will continue the manufacture of the disk grinders. The Ransom Mfg. Co. will confine itself entirely to the manufacture of motor-driven and belt-driven grinding machines and water tool grinders.

Driver-Harris Co., Harrison, N. J., announces that on January 31 its Insulated Wire and Electrical Cord Departments were completely destroyed by fire. However, the company's business in the production of resistance materials, castings, cold-rolled strip, nickel sheet, and other products has not been interfered with in the least, and business will continue as usual.

W. K. Millholland Machine Co., Indianapolis, Ind., manufacturer of turret lathes, whose factory was recently destroyed by fire, has leased the plant of the Climax Machinery Co. in Indianapolis and has resumed manufacturing, some shipments having already been made. Plans have been completed for a 90- by 300-foot fireproof building, on which construction work will be started at once.

Automatic Machine Co., Dayton, Ohio, designer and manufacturer of automatic and special machinery, tools, dies, and fixtures, which was organized about eighteen months ago, with M. O. Kepler as president and J. S. Kepler as vice-president and manager, has moved into the company's new building on W. Second St. This is a two-story and basement brick building with exceptionally good light. The new equipment secured for this building will double the company's present capacity.

Whitman & Barnes Mfg. Co., Akron, Ohio, maker of drop-forgings, elected the following officers at its annual directors' meeting: A. D. Armitage, president; W. H. Eager and A. B. Hall, vice-presidents; W. E. Rowell, secretary; and E. A. Fisher, treasurer. Mr. Armitage has been connected with the company for twenty-five years. He started as a mechanic in the Akron factory in 1892, and in 1915 he was elected vice-president and manager of the Chicago and Canadian factories, with charge of sales at those offices.

Ott Grinder Co., Indianapolis, Ind., the shops of which were completely burned January 13, has secured the plant formerly occupied by Stutz Auto Parts Co., at 217-221 W. 10th St., Indianapolis, and will occupy the entire building, which is of three-story modern concrete construction. The new factory is being rapidly equipped with an entirely new equipment, and regular deliveries will be made about March 15. The company has increased the sizes of the No. 2 universal grinder to 10 by 30 inches, and of the No. 8 plain grinder to 5 by 18 inches.

Fulton Steel Corporation, 165 Broadway, New York City, announces that its Heroult electrical plant at Fulton, N. Y., devoted to the making of alloy steels of different kinds, is now in successful operation. The plant has a capacity for melting about seventeen tons of steel per day. Irving R. Valentine, metallurgist of the corporation, who has personal supervision over the steel melting, worked for six years in the research laboratory of the General Electric Co., and has for several years been in charge of the Heroult electrical plant of that company.

Williams & Thomas Machinery Co., Inc., has been formed to handle a complete line of machine tools and railway and shipyard equipment. The company will have offices at 829 Commercial Trust Bldg., Philadelphia, Pa., and 1226 Fulton Bldg., Pittsburg, Pa. The president of the new concern is R. F. Williams, who has been connected for the past seven years with Manning, Maxwell & Moore, Inc., and more recently with Sherritt & Stoer Co., Inc., Philadelphia. George P. Thomas, who was formerly president of the Thomas Spacing Co., of Pittsburg, is secretary-treasurer.